THE

TROPICAL AGRICULTURIST

VOL. LVIII. PERADENIYA, JANUARY, 1922. **No. 1.**

AGRICULTURAL PUBLICITY.

The establishment of agricultural research institutes has naturally given rise to the question as to how their results can be presented to the agricultural public. In the United Kingdom a large number of such institutes has been organized in recent years in various parts of the country and a discussion has recently taken place as to how the Ministry of Agriculture can best keep agriculturists in touch with the work that is being done.

The Ministry of Agriculture for the United Kingdom has recently done much to improve its Journal and to incorporate in that the results of scientific research and investigations. It has endeavoured to present to the farming community those portions of agricultural research which have the most direct bearing upon the general practice on the farm.

There is a demand that the various bulletins and reports of research officers should be presented in a handy form for distribution through the Press. In other words, it is recommended that the system of Press bulletins or leaflets which has been the policy of the United States Department of Agriculture for many years should be adopted.

The research worker naturally is not inclined to make statements in regard to investigations in hand until such time as satisfactory conclusions have been arrived at. It is, however, possible to give short statements of the progress of work that is in hand. Such statements are of value and tend to keep the agricultural public alive to the work that is being carried out.

There has been a more marked tendency in recent years for the general Press to take an interest in agricultural research and it has been responsible for a good deal of propaganda and educational work. The Journals issued by Agricultural Departments are more eagerly sought after and the Agricultural Press has greatly improved in recent years and done much to disseminate the results of the investigations of research workers.

In Ceylon, the TROPICAL AGRICULTURIST has played an important part and every endeavour will continue to be made to present through that Journal the results of investigations of agricultural research workers not only in this country, but also in other tropical countries. Every agriculturist should support the journal, for it is necessary that the agriculturist in the tropics should be armed with the latest information that science is able to provide.

It is also to be hoped that the general Press of the Colony will devote even greater attention to agricultural matters. The welfare of the Colony is bound up at the present time in its agricultural industries, and these industries require that research work should be presented for the information of the practical man.

The results of investigations in Ceylon are regularly placed before the various Committees of the Board of Agriculture and thereby find their way into the Press, but the results of work in other Eastern countries is not so often alluded to.

The agriculturist of the future must maintain a mind receptive to new methods and new ideas and should be prepared to adopt for his own particular circumstances such information as is of real value to him. He should not depend alone on the work of Ceylon but should also look to other countries which are growing the same crops.

The number of workers is yet small and therefore it is essential that the research work of all tropical countries should be kept in view. In this, the Press can be of great assistance.

RUBBER.

SELECTIVE THINNING OUT OF RUBBER.

The following is a portion of an address on "Spacing and Thinning Out" delivered by MR. ASHPLANT to the local branch of the Rubber Growers' Association at Cochin on 26th October, 1921, and taken from the PLANTERS' CHRONICLE, Vol. XVI, No. 46 :—

The yields given by the different trees on any estate show enormous disparities. It has been stated that 75% of the rubber harvested is obtained from 25% of the trees. The remaining 25% of the crop, it might be further stated, is mostly drawn from a minority of the other trees. In all parts of an estate a few trees are found which are consistently giving out from a half to three-quarters of a cup of rubber daily throughout the year, or, expressed in another way, from 5 to 12 lb. of dry rubber annually. Right alongside these trees are others of the same age which scarcely ever yield more than a table-spoonful of latex on their best days, while for the whole year, their production of actual rubber is something in the range of half a pound. These differences in productiveness are permanent. Trees of the former class remain good yielders from year to year. Poor yielders remain poor as long as they are in normal health, and any considerable rise in productiveness on their part is an unfailing sign of disease.

The presence of so many small producers on an estate keeps the working costs high, while their retention year after year where the planting has been close seriously retards the healthy development of the better-class trees. Sooner or later, this overcrowding puts a limit to the productiveness of the estate, and the crop, after remaining stationary for a year or two, slowly begins to decline.

The various thinning-out experiments which have been conducted on rubber estates have led to somewhat erratic results, and this is necessarily so. Clearly everything depends upon the skill with which the trees destined for removal or retention are selected. If, as frequently happens, the selector is largely governed by considerations of spacing, and removes trees regardless of their yielding value, the output of an estate may be adversely affected for years. If on the other hand the thinning is done less on a positional than on a yield basis, the immediate drop in output will be small, and will speedily be made good by the improvement in the yielding qualities of the trees retained.

As an instance of what can be done under estate conditions by the selective removal of low yielders, a small experiment carried out by the writer a few years ago in Sumatra, may be quoted.

From an area of 12-year old rubber carrying 104 trees to the acre it was decided to remove 30 trees per acre. Three plots of 1,000 trees each were chosen, and the poor yielders designated by special mark,

Circumstances unfortunately prevented a long preliminary trial of the plots, and comparisons of the three plots before thinning had to be limited to about three months. A series of preliminary records for this period indicated the relative position of the three plots to be as follows :—

Plot A.	Plot B.	Plot C.
100	87	95

Immediately after thinning the yields from plots B and C, which were thinned down in each case from 1,040 to 740, declined, their position relative to control plot A, for the three months following the loss of trees being —

Plot A.	Plot B.	Plot C.
100	80	84
	—8% decline	—11½%

There was little alteration in the position of the plots until about seven months after thinning, when recovery set in. From this time onwards the outputs from the thinned plots steadily improved and, within nine months, were back at their old position. In May 1918 less than a year from the date of thinning, plot B was giving higher yields than before the loss of trees, the comparative figures for the three similar months of 1918 being :—

Plot A.	Plot B.	Plot C.
100	95	95

With slight fluctuations, this position was maintained throughout 1918-1919, and at the end of 1919, when the writer's observations ceased, there was no sign of backsliding in the yields of the thinned plots.

Leaving out of account the improvement in the health of the trees through the removal of injurious competitors, the point of commercial importance in this experiment is that within a year of the thinning not only was more rubber harvested from 1,480 trees than was previously obtained from 2,080 trees, but that owing to the use of fewer tappers and proportionately fewer cups, spouts, etc., this rubber was harvested for a little more than two-thirds of the former cost.

This result, it should be pointed out, was obtained from an area distinctly unfavourable for a thinning experiment, the trees thereon having been permanently injured and dwarfed in development by close planting. The trees were over twelve years old at the time, and no thinning to speak of had previously taken place. The sudden removal in one fell swoop, of two-thirds of the trees, had, therefore, a greater influence upon the crop than would have been the case had the trees been removed gradually, and in time.

Reliable figures from estates where the thinning operations have been initiated in time are difficult to obtain. Nearly every estate has commenced this work years too late. Such data as are available, however, show conclusively that progressive thinning out on sound principles from an early stage leads to a considerable improvement in the yield per tree, while the general development, the rate of bark renewal and position as regards diseases are markedly better than on unthinned estates.

Coming now to practical suggestions for thinning out. From what has gone before, it will be gathered that the proper time to commence thinning is within six months after planting out. From thenceforward and until

tapping begins, all unfavourable and badly diseased specimens should be removed. Assuming that the original planting is 15 × 15 or 200 trees to the acre, a reduction to 135 or thereabouts is desirable by the 7th year. After the yield values of the trees have been ascertained by trial tappings, thinning can proceed on a yield basis. If the poorer milkers are removed at the rate of 5 to 7 per year, a 15-year-old plantation will carry between 80 and 90 trees to the acre, a reasonable figure.

All this, of course, is very well, and progrsssive thinning-out, it will probably be granted, is a good policy for such estates as are still young, but what, it may be asked, is to be done with mature estates of 10 years and upwards whereon scarcely any thinning has been done, and where the trees have already acquired the drawn up crowns and contracted habit inseparable from prolonged over-crowding. Is it likely that the removal of a certain number of trees per acre will at this time of day benefit those remaining? Further, is it possible, under the stress of actual estate conditions to grade one's trees in a manner which will be satisfactory without being costly?

There can be no doubt as to the answer to all these questions. The experiments just recorded with 12-year-old trees, as well as others carried out with much younger trees, have demonstrated that selective thinning-out on a yield basis is possible under estate conditions. On old estates, where the problem of selection is complicated by the presence of bark and root diseases, and perhaps also by overtapping, it will be necessary in assessing the value of a tree to take account of many factors, but although an estimate based on yield will often have to be qualified, a knowledge of the yielding capacity of a tree will nevertheless be helpful in coming to a decision as to its retention or removal.

As the yield of a tree is markedly influenced by the quality of tapping, by disease (in the initial stages of Brown Bast the production may be two or three times normal,) as well as by many other factors, an estimate of the yielding powers of a tree which is based on a single observation at the time of tapping may be very erroneous. The institution of a system of yield marks is therefore necessary, and is an indispensable preliminary to any rational scheme of thinning-out.

One objection to the classification of trees on a yield basis is the very prevalent belief that actual measurement is necessary. The determination of the volume of latex in each cup by means of a graduated glass is a lengthy and somewhat costly business, and planters have rightly fought shy of it. One has, however, only to consider for a moment the extent of the information sought, to realise that accurate volumetric records of each tree's yield are quite unnecessary, and would in fact lead to the collection of so much detail as would be merely burdensome. for even if sufficient easily made signs for each trifling difference in volume could be found, few people would remember them. It may be noted here that whether a tree yields 50 or 60 c.c. and 120 or 150 c.c. is immaterial to the planter. What he wants to know is :—

1. Whether the tree is dry
2. Whether the tree is a very poor yielder
3. Whether the tree is a poor yielder
4. Whether the tree is a moderate yielder
5. Whether the tree is a good yielder
6. Whether the tree is a very good yielder
7. Whether the tree is an abnormally good yielder.

All this information can be gleaned by the simple observation of the cups, and without any recourse to measurement.

For most practical purposes connected with yield, therefore, trees can be divided into seven classes as indicated above. The marks denoting these classes will tell us all we want to know regarding the tree's yielding powers when thinning-out. For ease of marking, and to prevent confusion, it is desirable to have as simple a notation as possible.

BUD-GRAFTING OF RUBBER.

The following is a paper on the above subject, read by MAJOR GOUGH at a meeting of the Kajan District Planters' Association held on Friday, October 7th, and taken from the MALAYAN TIN AND RUBBER JOURNAL, Vol. X, No. 20 :—

While Duncan Committees, High Commissioners, Trades Commissioners and such like are endeavouring to devise means of weathering the present storm, it behoves the ordinary planter and his Directors to consider whether they are awake or slumbering, whether or not they are being left behind in the race for planting efficiency and cheap production. In the most important matter of "Bud-grafting," it may truthfully be said that in this country we are not being beaten in the race itself for lack of energy or speed, but because we have been left at the post peacefully thinking about past rubber booms and hoping for future ones, while our Dutch neighbours have tackled the question with energy and have nearly four years' start of us. It is claimed that "Bud-grafting" will double, treble, quadruple, or even more, the yield per acre. I believe this to be true but am not so sanguine as to expect much more than double, but even that would be enough to revolutionize the rubber industry, in time. I will describe the process for those who, like most people, have only the vaguest notion of what it is. Please remember that I do not for a moment pretend to be an expert, far from it. I have much to learn. I have, however, studied the question, and have had the benefit of the constant advice of our Government and M.P.A.A. scientists, and since February last have—except during the wintering season—been hard at work in the field and in the nursery, trying with very many failures, to put theory into practice. The result of this is that I expect to be responsible for completing the "Bud-grafting" of at least 600 acres this year, and more next. You will gather, therefore, that my many mistakes have at last enabled me to muddle forward into something approaching preliminary success. It is well known that every estate has a small number of very high yielding trees, trees which gave a full cup of latex at each tapping, while the average yield is less than a quarter of a cup, If only every tree gave this same amount, anyone good at arithmetic can multiply their present total yield by four and see the enormous increase the total shows. It is a sad fact that most of these trees give abnormal yields because there is something wrong with them, and presently they dry up. A few, however, yield highly because they are so constructed that they will always yield highly and bud-grafting is carried out in order to reproduce these exceptional trees throughout a whole estate. The natural high yielders can be discovered and tested by examining their latex rings and their roots,

which is not difficult. If there is a history of the yield for the past year or two, so much the better, and every planter who has not already done so, should at once begin to get his high yielding trees marked with their yield every month or two. This can do neither him nor the trees any harm and he may find later on that he is not sorry. If you strip a bud from a branch of such a tree and insert it close to the ground in a young tree from 8 to 18 months old, in the nursery or in the field, after the manner which I describe, the bud when it shoots will eventually form a tree which will present the physical characteristics of the parent tree. Some no doubt will not, but it may be taken as proved that quite enough will do so to make it vastly worth while. The Dutch now have four to five years old trees of this description but I have not been able to learn for certain what yield these trees are giving.

DUTCH EXPERIENCE.

I think that for the following reasons you may safely bet that the yield is not disappointing:—(1) Our scientists tell us that it is very probable that the yield of the parent tree will be reproduced in the scion and they appear to firmly believe that it will. (2) The Dutch in Java and Sumatra began their experiments carefully and slowly many years ago, and to-day a number of the very large estates are going ahead with bud-grafting as hard as they can. They appear to be very keen about it. With their previous experience they must know all about the subject now, and, as they are far from being fools, if results were not good they would be ceasing budding work and not redoubling their efforts. The larger sample of a shooting bud which I have brought to show you will enable you to realise that work can be done in the field as well as the nursery, though the latter is supposed to be preferable. Nurseries planted closer than 2 feet by 2 feet show poor results when budded, as I have found to my cost. Budding in the field on to stock thicker than 18 months' growth leaves a somewhat large dead end of stump to be dealt with after the tree is cut down. When young trees are cut down after being budded in the field, they grow again very quickly. I have shoots ten feet high and very strong which were budded in March last, only seven months ago—on 18 months' old trees. There are many pitfalls, however, and if I may give advice, I say "Begin as soon as you can, but go slow until you have gained experience."

EFFECT ON THE INDUSTRY.

As regards the effect bud-grafting will have on the rubber industry if it is the success that is thought certain. A trebled and quadrupled yield might make people wonder how the rubber will be absorbed. I do not believe there is any reason for panic. It is no use bud-grafting grown trees, and if you fell old trees and replant, the growth of the young trees will be very poor on most washed-out soils of the average rubber estate. What is left therefore, for old established companies to do? They should certainly, first of all, bud any newly planted clearings which they are lucky enough to possess, before the trees grow too large and then they should turn their attention to their reserve jungle and open it up for bud-grafting. If they have neither young clearings nor jungle, they had better begin to look about and see if they cannot get jungle ear-marked for them against the day when the Government again grants or sells lands. No estate can hope to be still prosperous eight to ten years hence, with only ordinary rubber if competing

against Dutch and other estates with areas producing rubber at perhaps 3*d*. per lb., but an estate with an appreciable area of budded rubber could tap that at a good profit and, at the same time, could devise schemes for extracting high yields of rubber at a profit by intensive tapping of divided up areas of their ordinary rubber, in rotation. In some such manner all estates might continue to show a good profit indefinitely.

ON THE INFLUENCE OF TAR ON HEVEA-BARK.

JOHANNES GANDRUP, Mag. Scient.

(Summary.)

The influence of tar on hevea-bark which had been scraped out to different depths was investigated.

The tar was applied partly warm and partly cold.

Two kinds of tar were used. One, coal-tar and the other a preparation made by the Dordtsche Petroleum Maatschappij called "Cambisan."

On all trees used for the experiment two spaces next to each other were scraped out and one was applied with tar, while the other remained untouched.

From each tree specimens had been taken at different periods from the tarred and untarred spaces for examination and comparison.

The result of the investigation was, that the tar had no influence on the renewal of the scraped out bark spaces.

The tarred space recovered in the same manner and just as fast as the untarred spaces.

The reforming of the stone cell ring, the cork and the latex-vessels showed no difference on the tarred and untarred spaces.

Some of the trees were scraped to a depth of the usual tapping cuts.

In these cases the coal-tar killed the remaining bark up to the wood, while the "cambisan" had no influence excepting that it, to some degree, withheld the drying out of the outer layer of cells, which were exposed by scraping.

It was therefore suggested not to tar the tapping surface and to merely apply it where the wood is exposed.

For instance when treating Pink disease and Die-back disease.

For this purpose the "Cambisan" tar may be recommended, for it remains for months forming a layer of tough solution and preventing the attacks of boring-beetles.

Black-thread canker should not be treated with tar because it is likely to cause larger wounds than those made by the disease itself.

These investigations are to be continued with brown bark diseased trees with the object of trying the system of treatment brought forward by MR. HARMSEN, viz., the scraping out of the bark and treating it with warm tar.

—ARCHIEF VOOR DE RUBBERCULTURE, 5E JAARGANG, No. 11.

TAPPING EVERY THREE DAYS.

The following is an extract taken from an article on the "Alternate-Day Tapping Recommended to Planters, appearing in the INDIA-RUBBER JOURNAL, Vol. LXII, No. 19 :—

Many planters and directors who consider that alternate daily tapping on half the section is too drastic have recently suggested that the length of line might be increased beyond the quarter if the trees are only tapped every third day. It is known to perhaps only a small number of people that some estates which have been tapped for years on this system have given most excellent results. It must, however, be pointed out that where such a system has been adopted it has generally been in operation from the commencement of tapping. It is quite probable that the results obtained by such a tapping frequency on an old estate which has been tapped for many years on various systems (but usually every day) would not give anything like so satisfactory results as those to which we refer. Nevertheless we think that such a frequency of tapping provides a way out of the difficulty for estates where the labour has been very much reduced and the superintendence brought down to the minimum.

PREPARATION OF RUBBER.

ARCHIEF VOOR RUBBECULTURE (1920, 4, 397) records the results of an investigation to overcome the early coagulation of latex caused by the lime salts contained in the water used to dilute the latex. Estates situated on highly calciferous soils have been faced with the difficulty that latex on dilution with well water, containing a high percentage of bicarbonate of lime, curdles very rapidly, necessitating the immediate and rapid handling of the collected tappings. The experiments showed that the Jewell filter using alum was not efficient in the case of these waters, but the reduction of the quantity of lime salts in the water to an insignificant amount was accomplished by adding slaked lime to the water. It is recommended that the water should be filtered after being drawn off from the subsiding tanks, either a Jewell filter or an ordinary sand filter being used for the purpose. Water purified by this treatment was found to cause practically no early coagulation, and the results are stated to have been very good in comparison with those produced by the untreated water. Estates using more or less dirty river water are advised to clarify the water by means of Jewell filter, and then reduce the lime content with the lime treatment described above.

—BULL of IMP. INST, Vol. No. 1, 1921.

RICE.

THE IMPROVEMENT OF PADDY CULTIVATION.

There is hardly any necessity for emphasizing the great importance that exists for the efficient cultivation of paddy, and the devising of means ready at hand for increasing the yield, as it forms the staple food of millions of people throughout the country. The importance of the subject was clearly exemplified during 1918-19 when, owing to a deficiency of reasonable rainfall, there was a partial failure of the paddy crop throughout the greater part of India and the neighbouring Crown Colony of Ceylon, and thousands of tons of rice had to be imported from Burmah to save the people practically from starvation. It did little more; for even with the augmented supply, rice was only obtainable at almost famine rates. But this failure was due to deficient rainfall over which no one can have any control; and it is well known that when seasons are impropitious the effects of fertilisers are partly nullified.

Before enquiring into the available means for improving the yield of paddy fields, it would be well to notice the practices that obtain with cultivators generally. This article refers more particularly to the practices prevalent in Coorg and the neighbouring uplands of Mysore, where paddy is cultivated side by side with coffee; but they may be taken as typical of other districts; a large part of South Canara for instance, except that two crops are raised in the latter to only one in the former.

The application of manure precedes the ploughing, except leaf manure which is trampled into the ground after the ploughing has proceeded for some time. Women are employed putting out the manure, which consists of refuse matter, paddy chaff, ashes, cattle droppings, etc., and is deposited at intervals over the fields, and sometimes lies exposed for months, but the ryots do not appear concerned about the loss manure exposed to the weather undergoes. Ploughing begins with the early rains in April and May, and is a very slow process, having to be done many times with the primitive plough most generally in use. This implement, which is shaped like a badly constructed "T" with one arm bent and shod with an iron nail for scratching the ground, costs about one rupee to make, the iron nail costing a few annas, and the balance going to pay the hire of the cooly who cuts the necessary wood in the jungle and shapes it.

Early in May and June (May in the Mysore uplands) the nursery beds are sown with seed. This seed is not selected but is a portion of the previous crop of paddy reserved for seed. The paddy fields in Coorg are divided into so many batties each. A batty equals 80 seers or measures so that a batty of paddy land did at one time, in the remote past, yield a batty of paddy grain. Now-a-days it yields from one-third to three-fourths of a batty. One hundred batties of land is equivalent to 33 1/3 acres. The

quantity of seed sown in a nursery to plant up that area ranges between 2 and 3 batties, a prodigal waste which is due to the practice of planting out bunches of from 5 to 15 seedlings in each spot.

When the ploughing is completed, the fields are levelled by means of a board drawn by bullocks and the fields being completely flooded. The transplanting of the paddy seedlings is commenced about July and continued into August. All work connected with the fields is finished before September in the localities here dealt with. In South Canara the planting out of the seedlings of the first crop is completed earlier, and the labourers are then at liberty to come up and work in the coffee estates. Some of them return about September to harvest the first crop, and after helping to sow the second crop, they return to the estates about November.

The most obvious means of improving the yield even with the ordinary manuring is, as the Agricultural Department has advised the cultivators to adopt, what is known as the single planting of paddy; that is, instead of putting down bunches of plants in each spot 9 inches apart to put down single plants at those intervals. Though some of the more enlightened cultivators have demonstrated to their own satisfaction on small areas that under this system the seedlings tiller freely produce ears of even size which mature uniformly—in short that it is unquestionably the best method of cultivating paddy, yet they are so wedded to old customs that they will continue immemorial practices. The objection raised is that single planting requires more labour as the coolies experience difficulty in picking out plants singly. This comes of sowing the nurseries too thickly with seed, when the seedlings grow up so thin and crowded that it is difficult to separate them. If in place of sowing a nursery with from 5 to 7 measures of seed, which is at present the practice, only 2 measures were sown over the same extent of nursery, the plants would grow up with very much thicker stems, there would be less difficulty in picking them out singly, especially if they were carried to the fields in baskets instead of being tied up in bundles. As a matter of fact it was found by MR. KOLANDEVALU UDAYAR of Kalli Rurichi Taluq, South Arcot, that single planting was more economical, for whereas in the old method it usually required 16 coolies to transplant one cawnie, under the new system it required only 10 coolies and they did it easily; for it is gratifying to note that the new method of planting paddy has commended itself to land owners in parts of the Madras Presidency notably in Arcot.

The above mentioned landowner found that with single planting and with unselected seed the yield was nearly doubled. Under the old system it was never more than 27 kalamas per acre; under the new it amounted to 45 kalamas. This Indian farmer tried the new system under the advice of the Agricultural Department, but it is to the credit of ABARANAM PILLAI of Chidambaram in the South of the Madras Presidency that he arrived at it by the exertion of his own intelligence. This is how it happened. A few seedlings were left over after transplanting a field. These he planted one by one along a channel. When the crop grew and came to maturity, it was observed that there were only 10 or 12 stems in each tuft where 6 or 7 seedlings had been planted together while the single seedlings produced as many as 20 shoots a piece; and while the ears of the first-mentioned plants were of irregular lengths and irregular maturity, the ears produced by the

shoots of the single plants were mostly of the same length, well-filled appearance and even maturity. This induced this intelligent man to try single planting the next year on one cent of land, and this produced 60 lb. of paddy equal to 6,000 lb. per acre. Naturally he extended the system to include his whole farm.

The next obvious means for improving the yield of paddy, as of any other cultivated plant, is seed selection. The ryot has been reprehensibly neglectful in this respect. Even if he has been aware of the difference in the grains, he seems to have been obsessed by the idea that every grain would make an equally good plant. It has been demonstrated that unselected seeds taken from single planted paddy tends to increase the crop ; how much more would this be the case if the seed were carefully selected? There is a praiseworthy practice in Coorg of procuring seed from outside the District once in 10 or 12 years ; but in this case also the seed is unselected.

Efficient ploughs have been adopted by intelligent cultivators. Let us hope that the day is not far distant when they will come into more general use. Their cost deters the poorer ryots from adopting them.

The great importance of the utilization of the right fertilizers for paddy is obvious. When efficient manures have been used even with the non-selection of seed and the old method of planting out seedlings, the results have been very good. How much more so would they if used in combination with careful seed selection and the approved modern method of planting the fields ! Where the fields are deficient in nitrogen the most obvious means of restoring their fertility is to grow leguminous crops and plough them in before putting down the staple crop. This is done to a large extent in the plains of maiden part of Mysore and parts of the Madras Presidency, but is sadly neglected in Coorg and the uplands of Mysore, the reason apparently being that the ryots in these parts consider the application of green jungle leaves an efficient substitute. The manures most generally used are practically purely nitrogenous, with the exception of the small quantity of potash contained in the ashes applied. It is usual to speak of cattle manure as being a complete general fertiliser, but as the products of its decay are chiefly ammonia and carbonic acid gas, and it liberates its mineral constituents very slowly, it may practically be classed as a purely nitrogenous manure. There are fields on which the paddy runs entirely to straw when cattle manure is applied. In these cases the application of phosphates and potash in a free state is called for. In one case in Arcot a landowner applied 312 lb. of bone meal per acre, and the resulting crop turned out 6,000 lb. of paddy per acre, while the straw was 5 feet high. Caste prejudice operates in most districts against the use of bone meal. In all such cases mineral phosphates might be used. As in the case of fields in Coorg and the uplands of Mysore jungle land is attached to them for purposes of supplying timber for buildings, wood for fuel and leaves and leafmould for fertilising the fields. Nitre beds might be made by making composts of jungle top soil, ashes and such cattle and pig manure as is available. These would make a more efficacious fertilizer than those generally utilised.—INDIAN SCIENTIFIC AGRICULTURIST, Vol. 2, No. 8.

SUGGESTIONS TO RYOTS OF SEED SELECTION AND IN THE PREPARATION OF PADDY NURSERY.

The importance of seed and its bearing on the succeeding crop is very great. Ryots are aware of this, but neglect this and do not care to bestow a little extra trouble. The demand for good seed is increasing from the ryots. Ryots have been repeatedly told about the importance of good seed and the question is so very important that it requires constant saying. In spite of repeated saying majority of ryots do not pay attention to seed selection. The care bestowed on getting good seeds will amply repay the ryot for his trouble.

If one takes a handful of seed from a ryot's stock and closely examines it the following facts are revealed : (1) The sample consists of a mixed lot and is not true to the type and that (2) some of the seeds are immature and imperfectly filled. This mixing of seed either takes place in the thrashing floor or in the field itself. Ryots generally cultivate more than one variety to suit their taste and convenience. These different varieties when harvested are thrashed in the same thrashing floor where they get mixed.

Secondly, during the course of a year or two in one and the same field two or more varieties of paddy are grown. When crops mature some grains that shed in the field germinate and grow when a different variety is sown or transplanted in that field. Such plants grow together at the time of harvest and get mixed up. When a paddy crop is growing if one cares to observe closely he may notice a few stray plants putting forth flowers here and there, while the main crop is still in blade. These earlier put forth earheads mature earlier than the main variety and the grains are likely to shed in the field before the main variety is harvested. This is not only a loss to the ryots but also increases the impurity of his seed. Such rogues should be mercilessly pulled out before they get ripened.

A closer examination of the plants will disclose that lot of variation exists between individual plants in the matter of tillering capacity of plants, size of earheads, packing of grains in the earhead, development of grains, uniform maturity and the like.

Although individual plant selection and further development on scientific lines is not within the scope of all ryots, a general selection of plants for seed purposes can advantageously be adopted by all ryots by bestowing some extra attention and care.

Some days before the harvest of a paddy crop a ryot can select a number of plants having similar desired characters. These plants should be harvested separately and threshed before general harvest. On account of heavy seed rate which the ryots are accustomed to use, they might think that the adoption of this system to select such a large quantity of seed is impracticable. The average holding of a ryot does not exceed 5 acres of wet land and in such cases it is within the reach of every ryot to select about 50 Madras measures of seed. An intelligent coolie can select seed for an acre in a day. Plant selection is possible in fields where seedlings have been planted singly. In bunch planted this method is not possible. A

simple method of seed selection (though not so very efficient as the above) can be adopted by selecting earheads either in the field before harvest or in the threshing floor after harvest. Earheads true to the type and having similar desired characters can be picked and thrashed separately from the main crop. This will give the ryot better seed than the one taken from the general heap.

The success of raising healthy seedlings depends upon good seed and good nursery. After securing good seed it is absolutely necessary that it should be sown in good, clean and well prepared nursery. Ryots do not often pay much attention to the selection of nursery plots but rather leave it to chance and convenience. Generally a plot close to a well is selected without considering the texture of the soil. Sometimes a plot which is not useful to grow a crop is set apart for a nursery. Such a defective selection is prejudicial to the healthy growth of the seedlings. An ideal nursery should be loamy in nature, free from weeds, level in position, free from shade and rich in organic matter. In stiff soils the seedlings do not grow well and very often the roots break at the time of pulling out. Every precaution should therefore be taken to have a clean nursery otherwise the weeds will overgrow the seedlings and check their growth. Further, these weeds will get mixed with the seedlings and at the time of transplanting will spread to other fields. The level position is very important in the case of wet nurseries. If the field is not level, the draining of water after the sowing of the seed becomes difficult. Water remains in the hollows and seeds rot in such places. For a few days after sowing the process of watering and draining should be done very carefully in order to have an uniform stand of seedlings. In an uneven nursery it is not possible to keep a uniform layer of water. Water will not reach elevated places and in such places the surface of the soil will crack and injure the tender roots of the seedlings and weeds will appear. Nursery should be free from shade otherwise the seedlings in shady places will grow lanky and their future growth will not be satisfactory. They are susceptible to insect and fungus attacks. Nursery plots should be heavily manured with the green leaves, well decomposed cattle manure or any other organic manure.

After securing good seed and well prepared nursery, the next consideration is how to sow the seed in the nursery. The seed should be sown thinly in the nursery at the rate of 1 Madras measure of seed in one cent of land, otherwise the seedlings will not develop properly. In thickly sown nursery seedlings grow thin and will not be fit for planting in singles. If the seedlings are kept for a few days more in the nursery they form nodes instead of putting forth tillerings. In the case of wet nursery great precaution should be taken not to allow the plots to get dry. If it is allowed to get dried up the surface soil will crack and the rootlets of the young seedling will break. Further the surface soil will become hard and the seedlings will break at the time of removing. Such broken seedlings when transplanted will perish in the field.

In these days of uncertain rains and water scarcity, the system of dry sowing and dry nursery are getting into popularity among ryots of certain localities. Seedlings from a dry nursery when transplanted in wet fields give

very good results and they can remain in the nursery for a longer time without forming nodes. In the case of wet nursery a ryot minimises the extent of nursery to the least as he has to face the exigencies of irrigation and sows the seed thickly. As there is not so much need for irrigation to a dry nursery the ryot does not grudge to give a large area to sow the seeds thinly which gives sufficient room for the seedling to tiller. The seedlings will then grow stout and healthy.

In preparing a dry nursery a ryot should take the following precautions. The plot should be ploughed seven or eight times in a dry condition at an interval of a week. Weeds should be carefully picked out and plot manured with well decomposed cattle or sheep manure and ashes.

Dry seed beds can be sown one and half or two months before transplanting time and carefully covered. The seed will germinate with aid of even little moisture present in the soil supplemented with rain. If there is not sufficient moisture for germination shallow channels will have made in the field at convenient distances and a splash irrigation should be given. In the dry nursery seedlings come up better, develop a better root system, do not form nodes and hence can be left in the nursery for a longer period. They tiller well and aid economic transplanting. When transplanted the seedlings come up well and give a heavier yield. This system of nursery deserves the attention of ryots and wherever possible dry nurseries should be raised. The entire success of the crop depends upon good seedlings and all possible care should, therefore, be taken to raise healthy seedlings which would pay the ryots for their labour.—VILLAGERS' CALENDAR OF MADRAS AGRIC. DEPT. FOR 1921-22.

GREEN MANURE CROPS FOR PADDY.

R. C. BROADFOOT,

Deputy Director of Agriculture.

Ryots are advised to grow green manure crops like Daincha and Kolinji for the purpose of ploughing these into the soil and thereby building up the supply of organic matter at a much lower cost than by the older method of collecting green leaves from the forest reserves and porambokes and trampling these into the soil.

The chief action of green manures is to increase the organic matter content of the soil and by growing one of the crops mentioned above up to 6 tons of green manure per acre may be obtained and there is no way in which organic matter can be added so cheaply. Now organic matter plays a very important part in paddy soils which on account of frequent puddling becomes very fine and close in texture ; green manures improve the texture considerably as on decay these make the soil porous and thus encourages a good flow of water through the soil without which the paddy crop although grown in water will not grow well. Green manures are also a potential source of plant food and where leguminous crops have been grown add considerably to the nitrogen content of the soil. Thus plants which belong to the legume family are most valuable.

As one crop paddy lands lie fallow for the greater part of the year, there is ample time in which to get a green manure crop and Government are prepared to assist the ryot by giving a supply of water free where such crops are grown. Ryots may also have the assistance and advice of officers of the Agricultural Department, who will furnish green manure seeds from certain depots on application.

Green manure crops are easy to grow ; and where Daincha is grown it is only necessary to sow the seed, irrigate and then by means of a brush harrow stir up sufficient mud to cover the seeds. Once the crop gets a hold it requires no further attention, because the large and deep root system makes the plant practically drought resisting. Daincha is suited to heavy and even saline soils but can be grown under a wide variety of conditions ; if sown 3 or 4 months previous to puddling season a strong and even rank growth may be obtained, in fact it may be necessary to top the plants and so encourage branching.

Wild Indigo or Kolinji is perhaps a more popular manure in Southern India and as it grows luxuriantly in reserved lands in some districts its leaves have been used for trampling into paddy soils for a long time. On paddy lands however this crop is not so easy to grow as Daincha as it will not grow on heavy water-logged or saline soils, but does well on soils which receive heavy coatings of silt annually. The seeds do not germinate readily and should be soaked for some time previous to sowing. But once the crop is established it grows well without irrigation. It is not regarded as so exhausting to the land as the previous crop, which of course is an introduction from Bengal and not therefore so well known as Kolinji.

Ryots are however inclined to set too much store upon green manures and while it is true that good crops of paddy have been grown for years with no other aid, it invariably happens that a dressing of other manures after the paddy crop has been established greatly increases the yield. The ryot therefore who wishes to have good crops and at the same time build up the fertility of his land is advised to apply some additional manure like fish guano which in combination with green manure forms a suitable mixture for the paddy crop.

Green manures supply little phosphorus and this in the form of a salt known as phosphate is essential for filling out the grains of all cereal crops. Phosphates also assist in early and uniform ripening of the crop. Bones are full of phosphates, so ground bone meal is a valuable manure.

Daincha seed can be obtained through the Agricultural Department at the rate of 5 annas per Madras measure and 3 to 5 Madras measures are sufficient to sow one acre. Kolinji can also be obtained through the same agency at $3\frac{1}{2}$ annas per Madras measure and 3 or 4 Madras measures are necessary for sowing one acre.—VILLAGERS' CALENDAR OF MADRAS AGRIC. DEPT. FOR 1921-22.

FRUITS.

PINE-APPLE GROWING IN CUBA.

B. MUNOS GINARTE.

(*in the Estacion experimenta agronomica, Santiago de las Vegas, Cuba, Boletin No. 45*).

Importance of the Pine-apple Crop.—In Cuba the cultivation of pine-apples is stationary whereas the demand for local consumption, export and the preparation of preserves is increasing continuously. The bulletin under consideration urges the growers to devote more ground to this fruit so that it becomes accessible to people of modest means. At present the fruit is not consumed so widely as was formerly the case.

Pine-apples are cultivated in the British and French colonies in Africa, in Ceylon, Siam, Cochin-China, Japan, Australia, Malaya, Melanesia, Polinesia, South America, Central America and Florida. The region best suited to the crop is the Antilles.

Varieties.—Many varieties are cultivated in Florida and the Antilles. In Florida WEBBER has described 25 varieties, the chief of which are red Spanish, Reine d'Espagne, black Jamaica, Grande Trinidad, Enville City, Abbaka, Cayenne, smooth Cayenne, Puerto Rico, and sugarloaf.

In Cuba there are two definite varieties, viz. "pina morada de Cuba" and "pina blanca" or "pina de la tierra," both having spiny leaves.

The "pina morada" has dark, thin narrow leaves, with thorns thinner than those of the "blanca" variety. It has been grown in Cuba since time immemorial, and is the most cultivated variety there not only because of its superior table qualities but because it is more hardy and travels well. The fruit is cylindrical, somewhat swollen in the centre, violet in colour before ripe and pale red when ripe. The flesh is bitter-sweet and light yellow in colour. There are many buds at the base of the fruit and there is a large regular crown (bud) on the top. In some places the fruit is harvested whilst quite sweet and in others somewhat acid with the result that it has been erroneously considered that the fruit belonged to two different varieties. The fruits weigh from 2·6 to 6·9 lb., and will keep about 3 weeks; they can be made into jam.

The "blanca" variety has larger leaves of a clear green colour and with sharp thorns. The fruit is conical, the base being greater than the length. It remains green until fully ripe, and has a white, juicy, slightly acid flesh.

This is the variety preferred for table use, which accounts for its high price. The fruit, however cannot be exported as it rots and ferments very rapidly. Antiseptics such as sulphur dioxide and alkaline sulphites and also protective envelopes have been used in attempts to preserve the fruit for exportation, but with little success.

In Trinidad an intermediate variety between the "morada" and the "blanca" is cultivated. Varieties have been introduced into Cuba from Florida but have not given satisfactory results.

Soils.—There are 4 well defined types of soils in Cuba :—

(1) *Coloured soils* ("*colorati*" abundant in the provinces of Havana, Matanzas, and certain regions in the north and east of the province of Pinar del Rio. The colour is due to the high content of limonite (iron ore); the soil contains 45 to 60% of sand and 20 to 35% of clay, and is of average consistency, well adapted to the cultivation of pine-apples, especially if the

sand is present in large grains, which allows of sufficient aeration for the roots. The plants live from 5 to 10 years but would last longer if fertilisers were used.

(2) *Sandy soils* in Pinar del Rio and other districts. They contain from 65 to 90% of sand (grains of all sizes) and 8 to 20% of clay. When the sand grains are large, the soil is well suited to the pine-apple which, however, does not do well in the "polvillo" (dusty soils) because they contain up to 55% of fine sand which chokes the roots. This is why the Cuban savannas (plains) are so sterile.

(3) *Black soils* are found all over the island. The colour is due to richness in organic matter and humus. They contain from 30 to 50% clay, and are of volcanic, calcareous, or granitic origin; they are of very close texture and not suitable for pine-apple cultivation.

(4) *Calcareous soils* are not very widespread in the island, although calcareous rocks are common, the reason being that the rocks contain a large proportion of other elements. These soils are not suitable for the pine-apple, because there is not sufficient aeration and they do not absorb sufficient heat.

Preparation of the Ground and Methods of Planting.—All stones, clods and roots are first removed by repeated ploughing followed by harrowing, and the ridges are made of a height that allows the soil to retain as much moisture as possible. In dry soils, i.e., where the water table is about 2 feet deep, and where the slope assists drainage, wide flat beds are used. Planting may be in simple lines, double lines and in groups of 3, 4, 5 or 6 lines well divided. The first two methods are the most usual.

When planted in single lines the pine-apples are placed at intervals of 1 to 2 ft., on top of the ridge with 1 to 6 ft., between the lines. This works out at about 14,000 to 15,000 plants per hectare. When double lines are used the plants are in squares 1 to 2 feet apart, 6 to 10 inches from each side of the ridge, the ridges being 3 ft. apart. This method, while utilising the soil better than the other has the same advantages, i.e., the plants grow well and cultivation and harvesting is easy. In plantations where there are 3 to 6 lines per furrow, planting is done in squares 15 inches to 2 ft. apart there being a distance of 5 to 9 in. from the ridges which are nearly 6 ft. apart. The advantage of this method is that the centre lines are not so productive as the outside ones.

The plots are 30 to 50 ft. wide, the lines about 17 inches apart and about 8 ft. wide is left every 195 ft.

Propagation.—The shoots growing in the axils of the leaves of the female plant are used, as well as those growing below the insertion of the fruit and forming the crown. The former shoots bear fruit 1 year after they are planted, and the latter after 18 to 20 months; plants growing from both are equally productive. The shoots forming on the fruit, and which are also part of the corona, could likewise be used for propagation, were it not that they are always removed with the fruit.

Shoots ready for planting are sold at 4 or 5 *pesos* (20 to 25 *fr.* at par) per thousand. When planting, care must be taken not to allow any soil to get into the axil of the leaves, or the shoot will die. It takes 8 days for 3 men to plant 1 hectare: one waters the place where the shoot is to be planted, another digs the hole and the third puts in the shoot, fills up the hole with earth and stamps it down.

Shoots from the roots or from the axils of the leaves are planted in spring and those from the crown in August and September. The latter type of shoots are the best to use, as the others are liable to be injured in separating them from the parent plant and the work is more costly and slower. Further, they are only found in abundance on old plants that are falling off. Another disadvantage is that the plants growing from root or leaf-axil

shoots bear smaller fruits than the crown shoots and those produced by the same plants the next year.

In order to turn to account the vacant spaces in new plantations, bananas, beans, etc., can be grown as catch-crops.

It is useless to sow pine-apples, for the seedlings only bear fruit the third year ; further, very few of the fruits contain seeds. PROF. CALVINE and the author have, however, used seeds in the work of improving the varieties now cultivated.

Shoots failing to strike, which hardly ever exceed a proportion of 10% are replaced 15 to 20 days after they were planted.

Cultural Operations.—These consist in keeping the ground very clean ; the plants are usually hoed twice, once when it is necessary to remove the supernumerary shoots (only 2 or 3 are left to replace the parent-plant) and again when the fruits are formed. The suckers that may have grown on the central fruit-bearing axis are cut away at the same time and props are put to the larger pine-apples, which by their weight tend to cause the stem to bend over right down to the ground.

Manuring.—In Cuba, a great mistake is made in not manuring the pine-apple crop, for with a fertiliser, larger fruit can be obtained. On the other hand, as the exporters pay the same price for all pine-apples, no matter what their size may be, there is no encouragement offered to the producer to grow finer fruit.

The author recommends a fertiliser containing 5% nitrogen, 4% phosphoric acid, and 10% potash, such as, for instance, a mixture consisting of 41·6 parts of dried blood (10 to 14% nitrogen) +8·8 parts of double superphosphate (40 to 45% phosphoric acid, 20 parts potassium sulphate, 50% potash) +29·6 parts of inert material (sand, soil, etc.).

The fertilisers should be applied as soon as the ridges are made and before planting. A good result is obtained by spreading over the shoot which has just been planted, sufficient dried blood or ground cotton cake to fill up the interstices between the leaves ; in this way, the plant is manured, and the soil prevented from lodging. No fertiliser should be spread before the shoots have taken root, that is to say, about 2 or 3 months after they are planted. The author advises 3 top-dressings with fertiliser ; the first, applied 2 to 3 months after planting, should consist of nitrogen 2 kg, phosphoric acid 1 kg., potash 4 kg., (this is enough for 1,000 plants) ; the second, used 6 months after planting, should contain, for 1,000 plants, nitrogen 1·5 kg., phosphoric acid 1·5 kg., potash 3 kg., and the third (also for 1,000 plants) should be composed of nitrogen 1 kg., phosphoric acid 1·5 kg. and potash 5 kg. and be spread in October or November, 2 months after the plants have flowered. After the flowers-stem has formed, fertilisers are injurious, for they tend to produce malformation of the fruit. It may be noted that in the successive application of fertilisers, the amount of nitrogen is decreased, in order to prevent the fruit becoming soft, and hence keeping and carrying badly ; the amount of potash, which has the contrary effect is increased. After gathering the crop, the shoots which are to produce new plants are manured with a fertiliser composed (for 1,000 plants) of 3 kg., nitrogen, 2 kg. phosphoric acid, and 4 kg. potash.

Harvest.—The pine-apples are known as 18, 24, 30, 36, 42, or 48, according to the number required to fill a small case called a "huacal" which is 92 cm. long, 26·5 m., wide and 30 cm. high. It is generally estimated that 90% of the Cuban variety of pine-apple, known as "Morada" bear fruits ; of these 60 to 70% are 24 to the "huacal" or larger, and the remainder are of different sizes. The second year after planting, 85% of the pine-apples bear fruit, but only 50% the third year. After the third season, it is advisable to make a new plantation, growing another kind of

crop in the pine-apple field. One man with 2 assistants, carrying alternately the fruits (neatly cut a little below their base) in baskets to a little cart, can gather 300 dozen pine-apples in a 10-hours day, which means that such a gang can clear one hectare in 4 days.

The pine-apples are taken to the packing-rooms, where they are allowed to cool at least for one night and are dried, if they have been cut in wet weather. They are then graded according to size, wrapped in paper, and packed. A good packer can fill 400 cases in one day.

Cultural Expenses.—The author gives the following figures as being most representative (1 peso equals 5 francs at par) :—

1. Expenses and Profits per Hectare of Pine-apples Grown for Local Consumption.

EXPENSES.

Ploughing four times	230·00
Ridging	92·50
Purchase of 15,000 shoots at 25 fr. per 1000 ...	375·00
Planting	200·00
Establishment Expenses ...	897·50
Interest at 1½% per month on 897·50 fr. for 18 months	242·10
Working expenses, hoeing, etc.	550·00
Rent of ground for 18 months	112·50
Interest on this outlay for 18 months : 662·50 fr. at 1½% per month	178·00
Expenses at end of first year ...	1,980·10 fr.

RETURNS.

From 15,000 plants, 90% of which bore fruit, were obtained 13,500 pine-apples selling at 1·50 fr. the dozen	1,687·50 fr.
Deficit ...	292·60 fr.

EXPENSES.

Cultural operations	305·00
Rent of ground for 1 year	75·00
Interest on 305 fr.	30·00
Total expenses ...	410·00 fr.

RETURNS.

From 15,000 plants, 85% of which bore fruit, were obtained 12,750 pine-apples fetching 1·50 fr. the dozen	1,593·00 fr.
Profits realised after deducting expenses of 2nd year	1,183·00 fr.
Profits realised after deducting first year's deficit together with the interest thereon, viz., 344·50 fr.	838·20 fr.

From this calculation, it would appear that no profits are realised until after the second year, but certain returns have been omitted, such as the sale of shoots, etc. From this source, according to the books of a cultivator and exporter, a profit of 920 *pesos* per *caballeria* (13·41 hectares) or 344 fr. at par per hectare is realised from the first year.

11.—Expenses and Profits of an Exporter.

(per hectare of pine-apples producing 135,000 fruits).

EXPENSES.

Cost of 1,125 dozen pine-apples at 1'50 fr. per doz.		1,687'50
Cutting the pine-apples		60'00
Three men with baskets		162'00
Motor transport of 1,125 doz. pine-apples ...		337'50
Making and nailing down 490 cases ...		171'50
Packing (4 men)		60'00
Transport to steamer, at 0'50 fr. per case ...		245'00
Supervision expenses		50'00
Total expenses ...		2,773'50

RECEIPTS.

490 cases at 7'50 fr.	3,675'00
Profits ...	901'50 fr.

In the region of Artemisia, the sale price of a case of pine-apples was: 7'50 fr. in 1917, 12'50 fr. in 1918 and 17'50 fr. in 1919.

Disease and Pests.—The pine-apple is subject to few diseases or pests, amongst which the following may be mentioned:—

(1) "Espiga larga" (*lit.* wide head):—The plant produces no central leaves and generally no fruit, or else produces a fruit of inferior quality. This disease is attributed to an insufficient amount of fertiliser, especially phosphatic. As a remedy, it is advised to use organic fertilisers with a nitrogen and phosphorus basis, such as dried blood, tankage, and bone-powder. The plants should also be carefully cultivated.

(2) "Marchitez" or wilting.—The roots assume an abnormal shape, the leaves change in colour from green to red then to yellow and afterwards become dark and wilt. As yet, little is known as to the cause of this disease, but it seems to be due to the bad condition of the soil, and want of proper rotation of crop. If the disease appears, the only course is to root up and burn all infected plants, to spread lime over the land, to leave the soil exposed to the sun for some weeks, and to aerate the soil again. When this has been done, new shoots may be planted to replace those that have been removed.

(3) "Hormiga brava" (*Solenopsis geminata* Fabr.) and its associate "queresa" (*Pseudococcus atri* Risso) make their nest in all parts of the pine-apple field and when they happen to place them under the roots of the plant they cause a great deal of injury. The best means of controlling these pests is to water the nests with the following mixture:—

Kerosene or refined paraffin ...	7'6	litres
Crude carbolic acid ...	0'5	,,
Caustic potash soap ...	225'	grammes
Water	3'8	litres

The soap is dissolved in hot water and the carbolic acid added; the mixture is then poured (stirring all the time), into the vessel containing the paraffin; this concentrated solution must be diluted with 18 volumes of water just before use.

Industrial Products obtained from the Pine-apple Plant.—The sap of the pine-apple contains 12'43% of crystallising sugar and 3'21% of glucose. The peel of the fruit, when macerated in water, yields an astringent juice which fermented with sugar, furnishes "garapigna" or "chicha" a diuretic beverage that is also said to be a vermifuge. The crushed leaves yield a sap that can be used for bleaching plant fibres (flax, hemp, etc.) and when diluted, forms a lye.

Amongst the products of the pine-apple he mentions:—*Preserved* pine-apples (plain; in brandy; in pine-apple syrup; jam); *Beverages* (pine-apple wine and cider; cream); textile fibres (fibres obtained from the leaves).—INTERNATIONAL REVIEW OF THE SCIENCE AND PRACTICE OF AGRICULTURE, YEAR XI, Nos. 11-12.

LIME.

THE MANUFACTURE OF CALCIUM CITRATE AND CITRIC ACID.

Considerable interest has recently been aroused in the West Indies in connexion with the citrus industry by the launching of a scheme, by the proprietors of a large estate in Dominica, whereby it is intended to manufacture citric acid direct from lime juice, instead of preparing for export the intermediate product, calcium citrate, as has formerly been the practice. It is thought that considerable financial gain will thus be effected, for, by localizing the whole process of manufacture to the district where the lime fruits are grown, a considerable saving in fuel and in transport and marketing expenses will be made, apart from the minimizing of delays and losses that are inevitably introduced by the employment of a discontinuous process.

The recent appearance of an article in the JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY, Vol. 13, No. 6, June 1921, by C. P. WILSON, entitled 'The Manufacture of Citric Acid from Lemons,' has suggested that a summary of the process of citric acid manufacture, as carried out along modern lines, might be of use to those who are interested in the progress of the citrus industry in the British West Indies. Investigations into certain phases of the citrus by-products' industry are being carried out in the laboratories of the Leeward Islands, and it is hoped that facts of some value to West Indian calcium citrate and citric acid manufacturers will shortly be made available.

OUTLINE OF THE PROCESS OF CITRIC ACID MANUFACTURE.

Pure citric acid is usually obtained from lemon or lime juice by a process consisting essentially of five stages :—

(A) *Precipitation of Calcium Citrate.*—The settled or clarified juice is heated, and lime (calcium hydroxide or carbonate or both) is added to precipitate the citric acid as calcium citrate.

(B) *Partial separation of Impurities from the Citrate.*—The precipitated calcium citrate is washed with hot water, and the excess of liquid then removed from it, either in some form of filter press, or by centrifuging.

(C) *Decomposition of the Citrate.*—The washed calcium citrate is suspended in water, and sulphuric acid is added in amount requisite for the complete decomposition of the citrate. The citric acid liberated by this reaction passes into solution ; the great part of the calcium sulphate simultaneously formed, settles as a fine white precipitate.

(D) *Concentration and Crystallisation.*—The supernatent liquid is decanted into open steam-heated evaporators and concentrated to a syrup. Crystallization is effected in shallow vessels. The crystals are separated from the mother-liquor by centrifuging.

(E) *Purification of the Crude Acid.*—The crystals obtained in the last stage are dissolved in warm water, and the impurities removed by suitable treatment. The purified liquor is finally concentrated *in vacus*; carefully filtered, and allowed to crystallize. Centrifuging, washing and drying the crystallized mass completes the process of manufacture.

WEST INDIAN PRACTICE.

Up to the present, the later stages in the manufacture of citric acid from the juice obtained from limes grown in certain of the West Indian Islands have been conducted in factories overseas. The partially purified calcium citrate, in a dry condition, is exported, or the lime juice, concentrated to a syrup by the simple process of boiling in more or less efficient evaporators, is transmitted through the usual trade channels, to the factory for further treatment.

The calcium citrate and the concentrated lime juice industries in the West Indies have been fully described by WATT* and MACINTYRE.† A concise summary of the subject is published in a pamphlet issued by the Imperial Commissioner of Agriculture, and entitled 'Lime Cultivation in the West Indies.' (1913, Pamphlet No. 72).

THE IMPURITIES PRESENT IN LIME JUICE AND IN CITRIC ACID LIQUORS.

As outlined in a previous section, the process whereby citric acid is prepared from lime juice would appear to be extremely simple. In practice, however, great attention must be paid to the details of purification if a high grade product is desired. This necessitates the employment of chemically controlled operations of a high degree of precision.

From the view point of the manufacturer, all substances, other than citric acid occurring in lime juice are to be considered as impurities. Some knowledge of the nature of these impurities is therefore a pre-requisite to a realization of the need for refinement in many of the operations involved in the manufacture of high grade citric acid, especially when wastage is to be minimized as completely as is economically possible.

Lime juice, as expressed from fresh ripe limes, is a pale yellow green turbid liquid, containing 7 to 9 per cent. by weight of citric acid, and 7·5 to 10 per cent. of total solids. A considerable quantity of pulpy matter, which renders the lime juice very difficult to filter, is present in it. On standing, the juice separates into three layers, a lower layer of pulp, a midde layer of clean liquid, and an upper layer of slimy scum. This scum contains appreciable amounts of essential oil of limes derived from the fruit rind.

As far as the writer is aware the exact composition of clear lime juice has not yet been determined. It may reasonably be inferred that it does not differ greatly from that of lemon juice, of which certain data are available. Lime juice probably contains besides citric acid, certain other acids, inorganic salts, sugars, proteins, pectic substances‡, gums, tannins, pigments and enzymotic substances. As expressed from the ripe fruits by milling, it also contains traces of essential oil of limes, which give it a characteristic flavour and aroma. After having been brought into contact with metals, lime juice

* WEST INDIAN BULLETIN, II, 1902 p. 308, VII, 1907, p. 331, VIII, 1908, p. 167; IX, 1909, p. 193. AGRICULTURAL NEWS, I, 1901 p. 99.

† WEST INDIAN BULLETIN, VIII, 1908, p. 171; XII, 1912, p. 465.

‡ *Pectic substances.* The cell walls of the pulp of many fruit contain a substance which is soluble in water and which gelatinizes when the solution is concentrated. It is known as pectin, and is probably formed from a hard substance, pectose, present in the cell walls of the unripe fruits. Citrus fruits, especially the orange, contain considerable amounts of pectic substances. These occur chiefly in the rind of the citrus fruit. Pectin confers the property of jellifying citrus fruit extracts in the preparation of marmalade.

becomes contaminated, to a greater or lesser extent, with metallic compounds, which have eventually to be removed when high grade citric acid is to be manufactured.

Certain of the above-named components of lime juice, notably the acids, salts and sugars, occur in a state of true solution; others are suspended in varying degrees of dispersion; and in other words, they occur in the colloidal state.

When left undisturbed for several days, lime juice possibly undergoes some sort of fermentation. This is assumed by analogy with the behaviour of lemon juice, as described by WILSON in his article on citric acid already cited. WILSON states that the fermentation process which proceeds in the case of lemon juice, results in the liquefaction of certain of the mucilaginous components, with a concomitant coagulation of others. Furthermore, sugars are probably entirely destroyed. Little loss of citric acid occurs, however, provided the juice is not allowed to ferment for too long a period.*

In the preparation of concentrated lime juice, and of calcium citrate in the West Indies it is customary to subject the juice to a preliminary distillation process, whereby most of the essential oil is recovered. The hot juice is then passed through filters, or is allowed to settle in large vats. In the latter procedure, little or no scum collects on the surface; the clear juice is simply run off from the sediment. In either case it is probable that the fermentative changes indicated above do not immediately take place in lime juice that has been heated to boiling point during the distillation of the freshly milled liquid, because the heating most probably sterilizes the juice.

Usually the solid matter is thrown away. Occasionally it is washed, and the washings incorporated with the clear juice. In a few instances, the solid matter is added to the fruit passing through the mill. There is always an appreciable waste of citric acid when these practices are followed.

Fresh lime juice, freed from the protecting layer of scum, slowly darkens on exposure to the air. This change is in all probability, due to the oxidation of certain components of the juice. It may possibly be governed by the activity of some oxidase† present in the juice, although the slowness of the process certainly indicates that oxidase activity is either absent or extremely sluggish. The fact that previously boiled lime juice slowly darkens in colour on standing, also argues against an oxidase being responsible for the change mentioned, for oxidases are destroyed at boiling temperature.

Probably fermented lime juice filters easily. In order completely to remove the coarser suspended matter that gives lime juice its turbidity, boiling from a short time with filter cel‡ followed by filtration, is found to be particularly effective. Such treatment is employed in the modern Californian citric acid factory described by WILSON (*loc cit.*). WILSON recommends that about 12 to 20 kilograms of filter cel per kilolitre of lemon juice (12 to 20 lb. per 100 gallons) be used.

---

* S. M. DAVIES has recently reported (AGRICULTURAL NEWS, XX, 492, March 5, 1921, p. 75) the extent of the loss in citric acid in second roller lime juice which was allowed to stand in a tub for nineteen days. The loss represented 14 per cent. of the original citric acid content of the juice, and is stated to be due to the activity of *Saccharomyces mycoderma*.

† An *oxidase* is an enzyme which has the power of accelerating the oxidation of various organic compounds. Its action is frequently indicated by a change of colour. A familiar instance is afforded by the darkening of a freshly cut surface of an apple or of an Irish potato when exposed to the air.

‡ *Filter cel* is an efficient absorptive agent prepared from some sort of diatomaceous earth. It may be obtained from the Cellite Products Company of 11 Broadway, New York. The price recently quoted is 1¾ cents per pound if taken in cartload lots direct from the factory. Allowing rate of exchange, freight and duty, it would probably cost about 4 cents per pound landed in the West Indies.

The protein, gum, and pectic substances in lime juice interfere to some extent with the crystallization of citric acid when the juice is concentrated to a syrup. Possibly during concentration these substances are partly decomposed. The decomposition products appear to contribute in some measure to the dark colour of the concentrated juice.

An exact knowledge of the identity and properties of the substances responsible for the colour of lime juice and lime products would appear to be highly desirable, for only with such knowledge will the manufacturer be able completely to eliminate them from lime products in the most economic manner possible. The subject is receiving attention in the laboratories of the Leeward Islands, and it is hoped that definite facts will be soon available for publication.

An exhaustive investigation into the colouring matters of sugar-cane juice and sugar factory products is being conducted in the laboratories of the Louisiana Sugar Experiment Station, under the able direction of DR. F. W. ZERBAN.* It has already led to results of far-reaching importance in connection with the manufacture of high-grade sugars and syrups. Such work is of a particularly difficult nature and calls for the exercise of extreme caution in the formulation of conclusions.

The results of the preliminary work conducted by the writer, in collaboration with F. H. S. WARNEFORD, on the colouring matters of lime products, suggests that the yellow and brown colours of these products, are chiefly due to polyphenol compounds, not unlike certain of those described by the Louisiana workers as occurring in cane juices and syrups. Without going into details, it is believed that fresh lime juice contains certain tannins or tannin-forming substances that yield coloured products during the several stages of citric acid manufacture. Of particular interest are the indications already obtained in the laboratories that these coloured products are chiefly due to oxidation. Especially noticeable is the rapid darkening which goes on when heated lime juice is neutralized by lime in the preparation of calcium citrate. A slight excess of lime in the liquor is accompanied by the appearance of a deep brown colour. A phenomenon of this sort due to oxidation is well known in the chemistry of tannins, and can easily be demonstrated by rendering alkaline a solution of some such compound as pyrogallol, and the addition of an alkali.

Lime juice, especially after keeping, on treatment with a solution of a ferric salt, yields a compound of red-brown colour, which, in all probability is an iron-polyphenol compound. It has long been known that lime juice, extracted by mills possessing iron rollers, yields darker coloured products than does juice extracted by means of granite rollers. The effect is especially noticeable when the iron rollers have been allowed to rust. These facts are exactly paralleled by experience in sugar manufacture. Undoubtedly the acidic substances present in most of the plant saps that receive treatment in plant products factories are the agents primarily responsible for the formation of soluble ferric salts by their corrosive action on iron surfaces with which the saps come into contact, more particularly when those surfaces are covered with iron rust.

A boiling aqueous solution of citric acid attacks pure iron only slowly. Ferrous hydrogen citrate is formed‡. The same acid, however, attacks ferric hydroxide (iron rust) quite readily, with the formation of ferric citrate‡. This latter compound (although itself not deeply coloured in dilute solution), being a soluble ferric salt, is capable of reacting with certain polyphenoles, such as various tannins, to yield compounds of an intense green or brown colour.

---

* See Abstracts in AGRICULTURAL NEWS, XX, 479, September 4, 1920, p. 278; XIX 483, October 30, 1920 p. 340; and XIX, 487, December 24, 1920, p. 406.

‡ WATT'S Dictionary of Chemistry.

A. E. COLLENS† reports an interesting analysis of a red-brown sediment taken from an iron vessel used in lime-juice concentration on a Dominica estate. Over 74 per cent. of iron calculated as ferric oxide soluble in hydrochloric acid was found in this sediment, and was present in large quantity as ferric citrate.

It is self-evident from the foregoing considerations that the surface of all iron vessels, pipes, machinery, etc., used in citric acid manufacture should be maintained in as clean a condition as possible, not only to minimize the production of deeply-coloured compounds but also to prevent the introduction into the citric acid liquors of objectionable quantities of iron, which are troublesome to remove in the preparation of high grade crystals.

The possibility of contamination of citric acid liquors by non ferrous metals such as copper, lead, tin and nickel, which are also used in the construction of various units of the citric acid plant, has received considerable attention. Whilst the non-ferrous metals are relatively unimportant from the view point of their being likely sources of colouration, their presence in citric acid crystals is highly undesirable, since much of the acid of best quality is intended eventually to enter into the composition of articles for human consumption.

A. E. COLLENS‡ has conducted an interesting investigation into the corrosive action of citric acid liquors on copper and brass under both factory and laboratory conditions. He found that strips of these materials immersed in fresh lime juice at air temperature in seven days lost respectively 0·167 and 0·110 per cent. of their weight. In boiling lime juice the loss was appreciably greater. Concentrated juice did not differ remarkably from fresh juice in its corrosive action on copper and brass. Various West Indian planters have reported some slight action of citric acid liquors on non-ferrous metals in the factory, but have stated that the corrosive effect is not great. There appears to be no reason for the preference for copper over brass in the construction of pumps, evaporator-coils, etc., in the citric acid factory, especially if hard brass be used. Nevertheless, great attention is paid in modern citric acid factories, producing the highest grade crystals to the removal of the merest traces of metals from the final liquors. Iron and nickel are removed by the use of calcium ferrocyanide ; copper, lead, tin, and antimony, by the use of hydrogen sulphide (WILSON, *loc. cit.*).

NOTES ON CERTAIN PHASES OF CITRIC ACID MANUFACTURE

(A) *Precipitation of Calcium Citrate.*—In West Indian citrate factories, the liming of lime juice is usually carried out as a rule-of-thumb procedure. Chalk or slaked lime, mixed into a cream with water, is added to the heated juice. The amount of lime to be added to a charge of juice is guessed. Occasionally the point of neutralization is roughly ascertained by testing a sample of the limed juice with a little chalk and with fresh lime juice. In some instances litmus paper is employed to indicate approximate neutrality. The rapid darkening in colour which occurs when the juice becomes alkaline as noted in the last section, is frequently taken as an indication that enough lime has been added. Much greater attention is paid to the liming process in many modern factories where chemical control is exercised. Thus WILSON (*loc. cit.*) describes the operation as practised in a Californian factory as follows. A change (of filtered lemon juice) consists of about 3,700 limes (800 gallons), and from a laboratory assay, the amount of calcium to precipitate the citric acid is calculated. In practice, sufficient hydrated lime of high purity is added to precipitate 90 per cent. of the total acid, calculated as citric. Sufficient calcium carbonate is then added to neutralize the remaining 10 per cent. of acid, and an excess of 7 kilograms (15½ lb.) of

† Unpublished record of the Leeward Islands Laboratory, 1918.

‡ Unpublished record of the Leeward Islands Laboratory, 1917.

calcium carbonate is added . . . . . Experience has shown that however great the excess of calcium carbonate added to the juice, there is always a small residual acidity, varying from 0·08 to 0·20 per cent., depending on the acidity of the original juice.* The last observation has been found to apply also to the conditions obtaining in West Indian citrate factories.

The liming process to precipitate citric acid from citrus juices, should be regarded as a very exact process, for as will be mentioned in the next section, the *state* of the precipitated calcium citrate is largely influenced by the conditions of precipitation, and is, in itself, a factor of considerable importance in regulating the ease with which the citrate can be cleansed.

(B) *Purification of Calcium Citrate.*—Calcium citrate, as obtained by digging out the sediment that settles in the liming tank in West Indian citrate factories, is far from pure. Apparently during precipitation it carries down many of the colloidal substances present in the lime juice. The extent to which this goes on depends on the state of the precipitate. WARNEFORD† noted the production of a white sediment of almost jelly-like consistency during the concentration of a citric acid liquor containing calcium citrate. This sediment proved to be calcium citrate, and must have existed in a highly dispersed state, possessing considerable absorptive powers. Certain West Indian planters have observed a difference in the amount of impurity carried down by calcium citrate in liming tanks, according as the conditions of the liming operation varied. WATTS recommended that the lime juice should be heated nearly to boiling point, since this 'causes the citrate of lime to become crystalline and to subside rapidly in a condition in which it is easily manipulated' (W.I.B. II, 1902, p. 312). When heating is not resorted to 'the citrate contains many impurities; it dries in the form of hard lumps, and when thrown into water it wets with difficulty' (*ibid*, p. 312).

The mechanism of precipitation has recently received considerable attention from colloid chemists. The effect of heat, of the concentration of the solution that yields the precipitate, of contained substances that are absorbed by it, and of many other variable factors, have severally been studied in relation to the state and physical properties of precipitated compounds in certain specific instances. The possible application of the results obtained in such investigations to the case of calcium citrate precipitation is receiving attention in the Government Laboratory of the Leeward Islands in an attempt to effect improvements in the existing methods of calcium citrate manufacture in the British West Indies.

(C) *Decomposition of the Citrate with Sulphuric Acid.*—This, and the following stages of the process of citric acid manufacture, as applied to the lemon industry of California, are admirably described by WILSON (*loc. cit.*) The decomposition stage may be summarized as follows. The washed calcium citrate is suspended in dilute liquor obtained in washing the previous batch of gypsum, and the amount of sulphuric acid, of Bé, 66° dilution, needed for the complete decomposition, is added. The end point of the ensuing reaction is checked by precise chemical tests, fully described in the article cited. The decomposition of the citrate is usually completed in about three hours. The precipitated calcium sulphate is allowed to settle and the acid liquor drawn off. The precipitate is washed free of citric acid by decantation on the counter-current principle. The residual

* It is difficult to explain this fact. Possibly the 'buffer action' of bicarbonates, phosphates, and perhaps certain organic compounds in citrus juices may account for the tardiness whereby exact neutrality is reached during the liming of citrus juices, as in sour soils, etc.

† Unpublished record of the Leeward Islands Laboratory, 1921.

calcium sulphate (gypsum) is sun-dried and sold as a fertilizer.‡ The acid liquor thus obtained, is a pale amber colour, and contains 12 to 15 per cent. of citric acid, and about 0·2 per cent. of sulphuric acid.

(D) *Concentration and Crystallization of the Citric Acid Liquor.*—In the Californian process as described by WILSON, the acid liquor is concentrated in lead-lined open evaporators equipped with lead steam coils. It is maintained in a state of incipient boiling, and is kept constantly agitated by means of air jets. When the density has reached 20° to 25° Bé, the concentrate is introduced into lead-lined vacuum pans, when it is further concentrated to 37° of 38° Bé. Crystallization is effected in shallow lead lined tanks provided with stirrers, and is usually complete in three to five days. The mother liquor is drawn off and further concentrated to produce another crop of crystals. The crystals are washed with cold water in a centrifugal, possessing a basket of bronze, in lining of monel-metal (an alloy of nickel and copper), and curbs of lead.

(E) *Purification of the Crude Acid.*—The crude citric acid crystals are dissolved in warm water and the solution freed from impurities by careful treatment, carried out under strict laboratory control.

The impurities to be removed are, (1) organic coloured compounds, (2) metallic compounds, (3) sulphuric acid, (4) calcium sulphate.

(1) *Organic compounds.*—The last traces of these that have escaped elimination of washing are removed from the solution of the crude crystals by warming the liquid to 70°C., and adding filter char.†

(2) *Metals.*—These are removed at the same time by adding the necessary precipitating agents already mentioned in an earlier section.

(3) *Sulphuric Acid.*—The liquor in the vacuum pan during the final concentration is tested for free sulphuric acid, and the calculated amount of milk of lime necessary for exact neutralization is added.

(4) *Calcium Sulphate.*—This compound is always present in a greater or lesser amount in the final liquor, which is usually saturated with calcium sulphate, causing encrustation in the vacuum pan.

The removal of calcium sulphate in the final operation, immediately precedes the crystallization of the concentrated purified citric acid syrup. It is postponed by filtering the liquor at the filter press. This final filtration is considered to be 'the most important signal operation in the production of high grade crystals.' Perfect filtration is attained by the use of heavy paper in addition to filter cloth, and frequently filter char is added to the liquor prior to the filtration.

The final liquor is a pale amber or straw-coloured liquid of density 36·6° Bé at 50° C. It yields a good crop of clear colourless citric acid crystals when allowed to remain perfectly still in monel-metal lined crystallizers.

No citric acid liquors are ever discarded in the factory. The final mother liquor is further concentrated and filtered. If of too deep a colour, it is caused to yield crude crystals, which are repurified; the mother liquor from these is diluted and treated as fresh juice.—AGRIC. NEWS, VOL. XX, Nos. 506 and 507.

---

‡ Calcium sulphate, as a fertilizer, is of great value in correcting infertility of soils containing excessive amounts of 'black alkali' (sodium carbonate), and to some extent of those containing 'white alkali' (sodium chloride, etc.) It may possibly be found to be efficacious when applied to certain soils of Antigua. To some extent, calcium sulphate may provide calcium when applied to sour soils whose infertility has been proved to be due to a deficiency of this element. Such soils possibly occur in certain of the wetter West Indian islands.

† *Filter char* is obtained by carbonizing filter cel that has been used for removing the coarser dispersoids in lemon juice at an earlier stage in the process of citric acid manufacture. A patent has been taken out for this product. (*See* WILSON, JOURNAL INDUSTRIAL ENGINEERING CHEMISTRY (loc. cit.)

CEYLON AGRICULTURE.

MINUTES OF MEETING OF THE FOOD PRODUCTS COMMITTEE: BOARD OF AGRICULTURE.

Minutes of a Meeting of the Food Products Committee of the Board of Agriculture held at the Council Chamber at 2 p.m. on December 14th, 1921.

Present:—The Hon'ble Mr. F. A. Stockdale, Director of Agriculture (Chairman), The Hon'ble Dr. H. M. Fernando, the Hon'ble Mr. J. H. Meedeniya Adigar, the Hon'ble Mr. O. C. Tillekeratne, the Hon'ble Mr. H. L. De Mel, C.B.E., Mr. P. B. Nugawela, Ratemahatmaya and Diyawadana Nilame, Gate Mudaliyar A. E. Rajapakse, Gate Mudaliyar L. A. Dassanayaka, Dr. W. A. de Silva, Dr. C. A. Hewavitarne, Mudaliyar E. F. Edirisinha, Mudaliyar V. M. Muttukumaru, Mudaliyar G. Gunatilake, Mudaliyar Edmund Peiris, Mr. C. W. Bibile, Ratemahatmaya; Mudaliyar J. H. Bahar, Mr. R. Senior-White, Mr. S. Tyagarajah, Mr. T. Waloopillai, the Divisional Agricultural Officers, Southern, Central and Northern Divisions, the Economic Botanist and Mr. N. Wickremaratne (Secretary).

Minutes of the Meeting held on August 24th were confirmed.

Agenda Item 2.

The CHAIRMAN tabled the Ordinance No. 37 of 1921 and mentioned that copies of the Ordinance (to make provision for the establishment and organisation of a Department of Agriculture) which had received the assent of the Governor have been issued to members and that he brought it before the meeting for their formal information.

Agenda Item 3.

Reply from Government regarding MR. A. SABAPATHY'S motion submitted at the last meeting regarding the reduction of rail freight on straw was tabled. The reply was that the present rate charged for the conveyance of straw by train has already been carefully considered and it has been decided by Government that the existing rates be not reduced, and that Government regretted that it was unable to approve of the recommendation.

DR. W. A. DE SILVA suggested that as the Government is disinclined to consider the question as a business proposition that Government should be asked to consider the case of certain districts where there was scarcity of cattle fodder and permit conveyance of straw free of charge,

MUDALIYAR V. M. MUTTUKUMARU agreed with DR. DE SILVA.

The CHAIRMAN explained that the original motion brought before the last meeting asked for the concession for Jaffna, but the resolution was amended extending it for the whole Island, and thought that the Committee may approach the Government as regards the Jaffna portion only.

It was agreed to ask Government to grant the concession from Anuradhapura to Jaffna.

Agenda Item 4.

The CHAIRMAN said that Government desired that the recommendation of the Committee appointed to enquire into cattle breeding in Ceylon that experiments to settle the possibility or otherwise of bringing fresh milk from Up-country into Colombo by rail should be given effect to. Experiments were carried out under the supervision of MR. G. HARBORD, Divisional Agricultural Officer, Central Division, in this connection during the period of June to October and that they have established that it is possible to bring sterilized milk to Colombo from Up country in Ice and that such milk keeps fresh at the ordinary temperature of Colombo for from 6 to 8 hours. He further stated that Negombo is now sending sterilized milk to Colombo in special bottles, and this might be advocated as the cost of construction of special railway vans was at present heavy.

MR. H. L. DE MEL made enquiries in regard to the special method of sterilizing.

DR. FERNANDO also took part in the discussion.

Agenda Item 5.

The CHAIRMAN laid on the table for the information of members details of the paddy manurial experiments which were carried out for the Maha season 1921-22. They consisted of 60 series and 228 plots with a view to test the relative value of green manures and other fertilizers.

MR. DE MEL said that he was using dadap leaves as green manures with good results and enquired whether dadap grown as shade could not be used for the purpose, and whether the growing of green manure is encouraged.

The CHAIRMAN said that where one crop is obtained green manure such as *Tephrosia*, Daincha, Sunn Hemp, etc., could be grown.

The Divisional Agricultural Officer, N.D., explained what was being done in Madras in the matter of application of green manure in paddy and the CHAIRMAN added that an increase of 20 per cent has been reported to have been obtained by the application of green manure in India.

Agenda Item 6.

The CHAIRMAN gave details of agricultural competitions for 1921-22 in connection with vegetable gardens and paddy. The total prizes offered in 10 of the Districts in the Island consisted of 81 prizes for paddy, 55 prizes for vegetable and 16 prizes for other gardens. Other competitions are in course of organisation in other districts. Funds for prizes have been provided for by Government, different Food Production Committees and also by several donors. The judging will take place in March and April, next year.

DR. W. A. DE SILVA suggested offering of prizes for devicing a safe contrivance for the conveyance of plantain and vegetables by railway.

The CHAIRMAN, MR. SENIOR-WHITE, DR. FERNANDO, and MEEDENIYA ADIGAR offered remarks on the suggestion.

The CHAIRMAN, with the consent of DR. DE SILVA, undertook to go into the question.

Agenda Item 7.

The CHAIRMAN gave a brief account of the work carried out by MR. SUMMERS, MR. ILIFF and MR. VAN BUUREN in connection with the

testing of varieties of paddy by selection and pure lines, and asked MR. ILIFF, the Economic Botanist, to read his paper.

MR. ILIFF read a statement on the subject.

The CHAIRMAN said that the main portion of the work was carried on at the Anuradhapura Experiment Station, and that the next crop would be ready for harvesting in February and March next, and invited members of the Committee to visit the Station, and see the work that was being done.

DR. FERNANDO wished to know whether seed paddy of any improved varieties were available for laying out an acre or two.

DR. HEWAVITARNE enquired whether seed paddy of 3 months varieties were available.

MR. ILIFF said that small quantities—a measure or two of each variety of short-aged and long-aged paddies were available, but he pointed out that the success depends on the suitability of the climatic conditions of other districts.

MR. O. C. TILLEKERATNE desired that the papers to be read at the meetings should be printed and circulated to members in future so that members would have an opportunity of studying the subjects and contributing comments.

The CHAIRMAN agreed.

Agenda Item 8.

The CHAIRMAN speaking on the subject of paddy cultivation by prison labour said that the question of the employment of prison labour in the cultivation of paddy in connection with food production had been discussed from time to time. A definite step was taken by the Department by the employment of 100 prisoners at the Experiment Station, Anuradhapura, in asweddumising lands for paddy. He gave details of the work done which went to show that the work done by the prisoners was satisfactory, their health had not suffered to any extent and that the prisoners had not complained of the work. He also mentioned that Government had agreed to extend the experiment for another six months.

A discussion followed in which MESSRS. H. L. DE MEL, A. E. RAJAPAKSE, W. A. DE SILVA, J. H. MEEDENIYA, P. B. NUGAWELA, S. TYAGARAJAH took part.

MR. DE MEL enquired the distance that the prisoners had to walk daily and the CHAIRMAN replied that the Experiment Station was 3 miles from the Anuradhapura Jail.

MR. RAJAPAKSE asked whether the work could be extended if it was found successful.

MR. DE SILVA remarked that it would be desirable to settle the prisoners on the land.

MR. DE MEL opposed to the settlement and suggested that particulars should be ascertained as regards the nationality, occupation, etc., in the first instance.

MR. MEEDENIYA said that having ascertained all particulars they should be given land.

The CHAIRMAN agreed to make necessary enquiries.

Agenda Item 9.

MR. C. DRIEBERG who was to move the discussion on the subject of "Bunchy Top" disease of plaintain was unavoidably absent and the CHAIRMAN placed his views on the matter before the meeting. The CHAIRMAN stated that MR. DRIEBERG desired to obtain definite information as to the

actual state of affairs as regards the disease so that all information obtained might through the press be circulated for the information of those interested.

MUDALIYARS RAJAPAKSE, PEIRIS and DR. FERNANDO offered remarks.

The CHAIRMAN asked the members to find out which varieties are immune from the attack of the disease as it would be possible to introduce such varieties to diseased areas.

It was agreed that the CHAIRMAN should make the necessary enquiries to obtain all information on the subject.

Agenda Item 10.

MR. R. SENIOR WHITE moved the consideration of the following proposals from the Food Production Committee of Matale :—

(a) Construction of an anicut across the stream Kaluganga at Nickwella.
(b) Improvement to Bowitenne channel and construction of anicut.
(c) Construction of Sigiriya Tank.
(d) Restoration of Dewaluwa Tank.
(e) Construction of an anicut across the Welamitioya.

He produced a map and explained the details of the proposed scheme.

In answer to a question from the chair he said that the proposals had not been submitted by the Food Production Committee to Government this year.

MESSRS. P. B. NUGAWELA, W. A. DE SILVA, DR. H. M. FERNANDO, MUDALIYARS E. F. EDIRISINHA and G. GUNATILLAKE offered remarks.

MR. SENIOR WHITE spoke in reply.

The CHAIRMAN proposed the postponement of the further consideration of the proposals and suggested that other Food Production Committees should be circularised and asked to submit a return of proposals similar to these.

This was agreed to.

The Meeting terminated at 4 p.m.

N. WICKREMARATNE,
Secretary, Food Products Committee.

MINUTES OF MEETING OF THE NORTH-WESTERN PROVINCE FOOD PRODUCTION COMMITTEE.

Proceedings of meeting of the Provincial Food Production Committee, North-Western Province, held on 7th November, 1921.

Present :—Mr. F. G. Tyrrell, Government Agent, N.-W. Province, in the chair, and Messrs. G. E. Madawala, J. G. Tennekoon, Ratamahatmayas ; the Hon'ble Mr. T. B. L. Moonemale, the Agricultural Instructor, Dandagamuwa, the Agricultural Instructor, Kurunegala, and Mudaliyar P. A. C. Ekeneligoda; Secretary.

Resolved that the best method of encouraging vegetable gardens is the provision of markets at which villagers can profitably dispose of vegetables grown by them, and the Ratemahatmayas be invited to establish weekly Fairs as at many centres as possible in their divisions.

It was considered desirable to hold vegetable garden competitions at present in the Kurunegala District.

Resolved that the Assistant Government Agent be asked to arrange such competitions in the Chilaw District if he thinks it desirable.

SOILS AND MANURES.

SOIL DEFICIENCIES.

HOW THEY ARE OVERCOME WITH FERTILIZERS.

The base of all agricultural practice is the soil; upon the capacity and proper management of soils all success in agriculture primarily depends. The plant secures from the soil and the air some fifteen different elements—and from these it adds to its growth. By a chemical analysis we find what different elements plants contain and the quantities such as lime, iron, nitrogen, phosphorus, etc. From studies made during the last one hundred years it has been found that of the different substances going into the composition of plants, the three which are most likely to be deficient in average soils are nitrogen, phosphorus, and potash. Soils may be benefitted by the addition of other elements, as lime, but it is believed to be due more to their physical action than the fact that the plant actually needs more of such elements than are already available in the soil.

In general a fertilizer may be said to be anything that improves the capacity of the soil to grow plants. A fertilizer may do this by, first, adding to the soil an element that is lacking and that is needed by the plants; or second, by improving the physical condition of the soil so that plants may take therefrom certain elements that are thereby rendered available. Moreover, certain fertilizers contain small organisms known as bacteria, which set free in the soil elements needed by the plant. It is largely for this reason and because of the decaying vegetable matter in it which improves the physical condition of the soil that manure makes one of the best fertilizers.

The elements of plant food most likely to be needed in soils are nitrogen, phosphorus, potash. Very good soils need all three of these, and in many instances lime also. Therefore, in improving the soil we must seek out and apply especially all the nitrogen, phosphorus and potash that we can find.

There is a fairly prevalent idea among farmers that a chemical analysis will show what a soil needs. This is only true in part, as a chemical analysis may show a certain element present and yet owing to certain combinations in the soil the plant cannot secure it. By far the better way is to apply fertilizers of different composition and note the results on small portions of the land. This the planter can carry out himself, and in doing it he is studying all the conditions that influence his particular farm and crop.

Suppose a portion of a field is divided into a series of ten twentieth-acre plots. These plots are fertilized as follows:—

No. 1—Nothing

No. 2—Nitrate of soda, 8 pounds; equal to 160 pounds per acre.

No. 3—Acid phosphate, 16 pounds; equal to 320 pounds per acre.

No. 4—Nitrate of potash, 8 pounds; equal to 160 pounds per acre.

No. 5—Nothing.

No. 6—Nitrate of soda, 16 pounds; acid phosphate, 16 pounds.

No. 7—Nitrate of soda, 16 pounds ; muriate of potash, 8 pounds.

No. 8—Acid phosphate, 32 pounds ; muriate of potash, 8 pounds.

No. 9—Nitrate of soda, 8 pounds ; acid phosphate, 16 pounds ; muriate of potash, 8 pounds.

No. 10—Nothing.

To one series of plots lime is also added to note its influence on the crops. It will be noted that these quantities are rather large, larger in fact than the farmer will use in general practice, but they are made so in order that the indications may be plain. This farmer should take note of the condition of his plots from time to time and by this means he can soon see what his particular soil and crop will need, and from the harvest from the crops on these small areas he can form some idea as to profit or loss.

Such experiments will save large sums to the farmer who is going to use fertilizers to any extent, and, moreover, it will teach him to observe and to follow a more rational scheme of agriculture.

In applying fertilizers that should be broad-casted and harrowed in for small grains that stand close upon the ground. For cane they should be applied in the hill as a rule, and they should be so placed that the plant will get the greatest benefit from them without reference to any crops that may follow. The fertilizers not only diffuse themselves through the ground, but the roots of the plants will seek out the fertilizers. It is advisable on hill lands to bury the fertilizer to guard against leaching by the rains.

Some definite scheme for fertilizing as has been outlined is far better than to follow a hit or miss plan of using a fertilizer without knowing the demands of the soil and crop. The soil may need only the one element, while the planter may be adding all three. Of course, in such cases, he is adding elements that do not make any definite return, and he is therefore making an outlay that is not justified, but by starting with small areas and using different combinations of fertilizing elements he can determine what his soils need without being liable to any appreciable loss. He can begin with the natural fertilizers, as manures, bat guanos, etc., that are within reach and use commercial fertilizers only as he finds it profitable to do so.

While it is doubtless true that most of our soils need nitrogen, phosphorus, and potash, and many of them lime, yet profitable combination is liable to vary very much, not only with different soils, but with different crops. It is found that different crops require more of one element and less of another. For example, maize requires all three—nitrogen, phosphorus, and potash—in liberal quantities ; beans and clovers, should have phosphorus and potash and be allowed to secure their nitrogen from the air. These crops will, for about every 30 pounds of phosphorus and 100 pounds of potash, require 100 pounds of nitrogen. Of this latter they are probably getting a larger part from the air, which means clear gain of the most expensive element.—SOUTH AFRICAN, SUGAR JOURNAL, Vol. 5, No. 10.

ARTIFICIAL FARMYARD MANURE.

No class of soil cultivators will be more interested than fruit-growers in the Rothamsted discovery of the simple method of converting straw into manure without the help of live stock. Fruit-growers, as a rule, do not keep much stock, if any, and they are finding it increasingly difficult to obtain sufficient supplies of town stable manure. Yet they cannot grow their crops for long without some form of organic nitrogenous manure, of which farmyard or stable manure is the best. As a result of investigations carried out at the Rothamsted Experiment Station, it has been found that straw can be converted into an excellent imitation of farmyard manure with the help of nothing more elaborate than water and some soluble nitrogen compound, of which sulphate of ammonia is at present most easily obtainable. Repeated experiments have shown that the most rapid breakdown of straw occurs when some source of nitrogen is supplied, and then only in those cases where the reaction of the solution is neutral or slightly alkaline. As sulphate of ammonia tends to be acid, finely ground chalk or lime stone must be used with it to neutralise the solution. For general purposes three-quarters of a hundred-weight of sulphate of ammonia and one hundred-weight of finely ground chalk per ton of straw are sufficient to induce fermentation. The process of making the manure is quite simple. The only trouble arises from the tardiness with which the straw takes up the moisture necessary for fermentation. It is suggested that the most effective method is to water the straw lightly at first, and leave it for a couple of days. During this time a slight fermentation with increase in temperature sets in, rendering the straw more capable of absorbing a second slight application of water. When examination shows that the interior of the heap has become uniformly moist, the sulphate of ammonia and chalk can be broadcasted over the surface and watered in. After this fermentation soon becomes more rapid, and may be assisted by turning the heap to admit air, just as is done with ordinary farmyard manure when the desire is to make it heat and rot down quickly. Nitrolim may be used in place of sulphate of ammonia, in which case no ground chalk is required. Manure made as described must be inferior to real farmyard manure in that it is not a complete fertiliser. It must be considered as supplying only nitrogen and humus. But it is an easy matter to provide the necessary phosphates and potash in the form of mineral fertilisers.—GARDENERS' CHRONICLE, VOL. LXX. No. 1820.

TO MAKE LIQUID MANURE.

E. N. WARD,

Superintendent, Botanic Gardens.

Soak a sugar bag of fresh cow, pig, or poultry manure for a week in 50 gallons of water. Use this at the rate of one part for three parts of fresh water. The same bag of manure will make another 50 gallons by using one part of the liquid to one part of fresh water. A third quantity of 50 gallons may then be prepared and used neat. Each 50 gallons should be a week old before using.

This form of liquid manure is all that is necessary for most growing crops used weekly. Apply 4 gallons to every 18 feet of a running row. No further stimulants need be added.—AGRIC. GAZ., N.S.W. Vol. XXXII, Part 9.

PESTS AND DISEASES.

THE MINISTRY'S RESEARCH (RAT) LABORATORY.

In the JOURNAL OF THE MINISTRY OF AGRICULTURE for November, 1921, appears an article on the "Ministry's Research (Rat) Laboratory." by C. L. CLAREMONT, B.Sc. (London), F.I.C., Research Chemist, Rat Destruction Branch, from which the following notes have been abstracted :—

The necessity for rat destruction cannot be questioned. Statistics show the enormous material-damage, amounting to many millions of pounds sterling annually, caused by rats and mice in destroying property, especially stored and growing foodstuffs : while the danger of rats and mice as carriers of diseases which attack human beings and domestic animals is well-known,

METHODS OF DESTRUCTION.

Four methods of rat destruction are available, namely, hunting, trapping, the use of virus and poisoning.

The first two methods need not be discussed at length ; both are limited in their application, and in the case of trapping there is difficulty in taking sufficient numbers to clear badly infested areas. Further, rats soon become weary of traps of all kinds and avoid them. Mention might here be made of the method of destruction known as the "Rodier" system. This depends on trapping alive, destroying all females caught, and releasing the males. It is supposed that the males, then greatly outnumbering the femaless will prey on each other and on the surviving females.

The Virus Method was hailed a great advance in scientific rat destruction, but experience has hardly justified the claims made for it. The virus method depends on feeding the rats with baits containing cultures of living germs ; these infect the animals which die in 10 or 12 days and the disease spreads among the survivors. Unfortunately there are objections to this method which in many respects, offers an ideal means of destruction. These objections are :—(1) The varying susceptibility of the rats to the disease, as some do not die when they take the germs ; (2) Sublethal doses tend to immunise the rats to the disease so that a relatively immune race of rats would be evolved ; and (3) there is the risk of the organism used being either initially pathogenic to other animals or devolving in its passage through the rat a higher virulence which might affect other animals, and even human beings. Cases of illness in human beings have been attributed to rat virus. (4) Lastly, there is some doubt as to the extent to which the disease is transmitted from rat to rat, for as it is not a contagious disease it can only be transmitted by ingestion of the germs. For these reasons the Ministry of Agriculture and the Ministry of Health do not favour the virus method of destruction.

Poisoning is by far the most important method. With proper precautions it can be used anywhere ; when suitably applied it is remarkably effective ; and it therefore offers the best solution of the problem at present.

It should be noted that all methods of rat destruction should be carried out in conjunction with rat proofing, for in the end it is largely the amount of shelter and food available which determines the rat population.

WHY RESEARCH IS NECESSARY.

From the above remarks on the virus method, it is clear that there is a wide field for further work, which can only be done in properly-equipped bacteriological laboratories by a scientific staff. In the case of poison, it might be thought that the need for research is not obvious, but poisoning is a certain and much-used method and the need is real. It is necessary to know, for instance, what is the least quantity of poison which will kill a rat of average size ; what quantity to put in the bait; and how much bait to use. Another very important question is the extent to which poisons are dangerous to other animals. Even trapping is not so simple as it seems, for experiments in India and elsewhere show that the dimensions of the trap are of great importance.

THE MINISTRY'S LABORATORY.

The Research (Rat) Laboratory and Factory are situated on the top floor of one of the old blocks at Mount Pleasant Post Office, E.C. The staff consists of the Research Chemist (who is responsible for the chemical and biological work and also for the management of the factory), one laboratory assistant, and two men and a boy for the factory work.

The work of the Laboratory includes the chemical examination of various proprietary raticides on the market as well as many rat poisons the formulæ of which are supposed to be secret but which usually prove to contain nothing startling. In addition, raw materials purchased for the factory, or submitted from outside sources, are examined and toxicological analyses made in cases where rat poison is suspected.

OTHER POISONS.

It has already been indicated that the choice of a poison is very wide ; the poisons actually in use, however, are comparatively few. It may be well to summarise the requirements of a practical rat poison. It must be :—

1. Relatively harmless to domestic animals.
2. Cheap and readily procurable.
3. Effective on rats and mice, that is, reasonably small doses should kill.
4. Tasteless, or, at any rate, without a repellant taste.
5. Easy and clean to handle and be readily incorporated for making the bait.
6. Capable of keeping well and retaining its toxicity.

The first condition practically eliminates all the substances popularly recognised as poisons ; nevertheless a great many of the rat poisons on the market contain either arsenic, strychnine, or phosphorus. Where there is little or no risk of poisoning other animals, the use of these poisons is safe enough, and they are certainly effective, though arsenic is somewhat variable in its results, while the use of phosphorus is attended by some risk. Actually, strychnine is said to be cheapest, per rat killed. As a general rule, however, the indiscriminate use of these dangerous poisons is to be deprecated, and the use of less dangerous poisons should be encouraged.

Of the less dangerous poisons Barium Carbonate and Red Squill have been found most effective for killing rats, and they have the great advantage of being far less poisonous to domestic animals and human beings.

THE COMPOSITION OF BAITS.

Experiments carried out at the Laboratory showed that rats eat about one-tenth of their body weight per diem ; hence a bait of 30 to 40 grains is suitable and represents about one-tenth of a day's food supply. Each such bait should contain a lethal dose ; to obtain this, the following percentages of toxic agent in the baits prepared are used :—

Arsenic 5%	...	Each bait being about 20 grains
Barium Carbonate 25%	...	,, ,, ,, ,, 30 ,,
Squill Bulbs 20%	...	,, ,, ,, ,, 50 ,,
Squill Powder 20%	...	,, ,, ,, ,, 25 ,,

Successful rat destruction depends not only on the choice of suitable toxic agents, made with due regard to their chemical and toxic properties, but also on the adaptability of the baits to the varying taste of the rat.

COCONUT CATERPILLAR PEST.

An account of a caterpillar pest which attacks the leaves of coconut palms in Indo-China is published in the Bull. Agric. Inst. Sci. Saigon (1921, 3, 26). The caterpillar forms a sheath from pieces of the leaves, which are bound together with silky threads. In these sheaths, which are attached to the leaves by strands of silk, the caterpillars live and undergo their metamorphosis. The caterpillars are brownish-red in colour, and from 12 to 15 millimetres long. They may be destroyed by spraying the leaves with arsenical insecticides, preferably a little before or after the hatching of the eggs, and in any case not later than a week before the caterpillars have attained their full development. This treatment is practicable only for young coconut palms, unless powerful pumps are employed. Destruction of the chrysalides and of the eggs may be effected by collecting and burning the attacked leaves, but this treatment has the disadvantage that useful parasites the larvæ of which attack the caterpillars, are also destroyed. To obviate this, it is suggested that the collected leaves should be stored in wooden or masonry structures, equipped with well-fitting doors, where the moths and the parasitic flies would emerge, the latter being allowed to escape through apertures covered with perforated metal, the holes of which are sufficiently small to keep the moths inside. The leaves are burned the year after their collection. A suitable arsenical insecticide is prepared from a mixture of sodium arsenate and lead acetate. Such a spray adheres well to the leaves and does not burn them.—Bull. of Imp. Inst. Vol. XIX, No. I, 1921.

TRADE MARK 'TABLOID' GRAND

Medicine Chest

No. 254

No. 254 'Tabloid' Medicine Chest
Measurements: 9 × 6¾ × 6¼ in.

A compact yet comprehensive equipment containing medicaments, dressings, etc., which always maintain their efficiency in tropical climates.

Particularly adapted to the needs of settlers and planters. The ideal medical equipment for out-stations, works and camps.

Obtainable from all Chemists and Stores

BURROUGHS WELLCOME & CO., LONDON
AND COOK'S BUILDING, HORNBY ROAD, BOMBAY
xx 2703
All Rights Reserved

OILS.

BAY OIL IN MONTSERRAT.

Considerable interest is being taken in Barbados and other places in the production of bay oil, on account of the high import duties that have recently been imposed. MR. ROBSON, Curator, Montserrat, has done pioneer work on the cultivation of the Bay tree and distillation of the oil, and the following is taken from his Annual Report for 1919-20 just published :—

The results from the bay tree experiment plot in 1919 are, from the point of view of total yield of leaves and oil, the most successful yet obtained in the history of the plot.

To make the position clear in regard to the establishing of this plot, it may again be mentioned that it was planted in 1908 with seedling bay trees which had been raised in pots at the Botanic Station, and is 1 acre in extent. The planting distance was 9 feet between the rows, and 6 feet between plants in the row, or about 800 plants to the acre.

The reaping of the leaves from the plot for distillation was commenced in January 1911, two and a half years from planting, and the reaping and distillation of the crop have been systematically followed up since that time. (For further details of the early history of the plot, refer to the WEST INDIAN BULLETIN, Vol. XV, pp. 176-97).

A table is given in the Report showing the quantity of leaves reaped in each season, the actual yield of oil obtained for the nine years, together with the estimated gross value of the oil, which in 1919 was £60 per acre.

It should be stated that, although fifty-two distillations were made of leaves reaped from the plot, it was not possible to deal in the still at the Botanic Station with the total quantity reaped, and therefore 1,255 lb. were sold to a distiller at the close of the year.

The plot remained in a very vigorous condition at the close of the year, and several thousands of pounds of leaves were left unreaped on account of the inability to deal with them.

It is found in actual practice that once the trees are sufficiently developed actually to cover the ground occupied, less and less cultivation is required, and the necessary cultivation is reduced to a minimum.

During the year under review, fifty-two distillations of leaves were made, and samples of the oil from each distillation (100 e.e. each) were as usual submitted to, and examined at the Government Laboratory at Antigua, To keep in line with the data on record as the result of work in previous years, the details in connexion with each distillation are given in MR. ROBSON'S report.

The average yield of oil per 100 lb. of green leaves in this season on the whole of the distillation, is 17·3 oz., compared with an average of 18·6 per 100 lb. in the previous year.

Reference to the table giving the results in 1919 again shows considerable fluctuations in the amount of oil per 100 lb. leaves, even within the same month, and no very satisfactory explanation can be given for these varying results, except on the hypothesis put forward in last year's report that the reapings are made from seedling trees, the inherent capacity of which, as oil yielders, varies considerably, and more chance decides whether the trees reaped from are good or bad yielders.

The methods of distillation carried on over the last three years have been uniform ; the leaves were reaped from the plot one day and distilled the following day. The actual distillation is prolonged for nine hours from the first appearance of the distillate at the condenser outlet. This enables the bulk of the heavy oil, that with a specific gravity greater than 1, to be obtained, though it is recognized that small proportions of heavy oil remain to pass over even after nine hours' distillation.

Apart from the accumulation of the total amount of oil from the experiment plot, one of the more immediate objects of making the frequent distillations throughout the year has been to decide if any particular season of the year is more favourable for the reaping and distillation of the growth such as might be indicated by a larger weight of oil from a given quantity of leaves, or an improvement in the quality of the oil as shown from the specific gravity and phenol content figures. The results would probably have been more reliable, had exactly the same quantity of leaves been treated at each distillation ; but this was found to be impracticable, on account of the experiment plot being situated about 2 miles from the Experiment Station, and the reaping of the leaves necessarily being left in the hands of labourers, with no ready means of weighing the leaves at the experiment plot.

Anyone interested in the details as collected from the separate distillations made for several years will find them recorded in the Annual Reports on the Botanic Station. In MR. ROBSON'S 1919-20 report is given a summary of the results obtained for the last three years, 1917-19 inclusive namely, the number of distillations conducted each month, the monthly average of oil per 100 lb. green leaves, with the average specific gravity and the phenol content for the years 1917, 1918, and 1919.

It is seen that the average yield of oil for the three years is 17·9 oz. per 100 lb. fresh leaves, with very striking contrasts so far as actual yield is concerned between the individual tests.

The figures show that the best average results for yield have been obtained in the early months of the year, i.e., between January and July. This, however, may be entirely due to the effect of the usual dry weather at this time of the year, and to the leaves having a reduced water content as the result of evaporation. As the result of further experiments conducted in 1920, which will be referred to in a latter report, this explanation appears to have been definitely established.

On the question of the quality of the oil as indicated by the specific gravity and the phenol content, between which a certain correlation is noticed, the best results in 1917 are seen to be in March, April, and May ; in 1918, in June and July ; and in 1919, in the month of October.

Throughout the work conducted on the experiment plot, it has been the practice to include only in the growth collected for distillation, what was seen to be fully developed, and to discard as far as possible all the young immature growth. This at certain seasons of the year, when the trees are making new growth, is difficult to achieve, and the conclusion is formed that the reaping and distillation of growth should not be attempted at the periods when the trees are making new growth.

To confine the reapings of the leaves to mature growth would be easily possible of accomplishment, only when the treatment given to the trees follows the lines carried out on this experiment plot, for the reason that when reapings of the leaves are made, and the trees beheaded, strong vigorous shoots are developed from the apex of the plant, which sooner or later reach a stage, depending on the weather experienced, in which the resulting growth reaches the stage of maturity. It may here be repeated, that the bay trees on the experiment plot in question are so treated that reapings of the leaves can be made from the ground level, which is accomplished by beheading the trees with a saw, the leaves being stripped from the severed branches later. Under the conditions of the experiment plot, it is found that the beheading of the trees can be done once a year.

There is a probable objection to the collection of the very oldest leaves from the trees, though further research is necessary in this direction. The distillation performed on October 24, 1919, consisted of the oldest leaves that could be found on the trees only, and were hand picked. There are no observations to show just how long leaves are retained before natural shedding takes place, but it seems safe to assume that many of the leaves distilled had been on the trees for at least two years. Reference to the results of this particular distillation shows that they are disappointing in every respect.—AGRIC. NEWS, Vol. XX, No. 503.

A CONTRIBUTION TO THE STUDY OF THE CITRONELLAS.

SCHÆFFER.

The citronellas belong to the genus *Cymbopogon* of the family *Gramineæ* and are plants that yield essential oils. According to DR. P. STAPF,* the genus includes :

(1) "Palmarosa": *C. Martini* Stapf. var. *Motia=Andropogon Martini* Roxb.

(2) "Ginger Grass": *C. Martini* Stapf var *Sofia=A. Martini* Roxb.

(3) "Lemon Grass": *C. citratus* Stapf.=*A. citratus* D.C.
C. flexuosus Stapf.
C. pendulus Stapf.
C. coloratus Stapf.

(4) "Citronella": *C. Nardus* Rendle var. *Linnæi* (typicus) Stapf.
C. Nardus Rendle var. *confertiflorus* Stapf.
C. Nardus Rendle var. "Lena-batu"
C. Winterianus Jowitt "Maha-pengiri"

The author studies these different varieties successively. The cultivated citronellas are *C. Winterianus* Jowitt, or "Maha-pengiri" and *C. Nardus*, or "Lena-batu."

He also studied the citronella in Ceylon and in Java from the standpoint of cultivation, uses, and trade. By distillation, oil of citronella is obtained; this consists of geraniol and citronnellal, which are employed in perfumery and soap-making, chiefly on account of the strong rose scent of the geraniol. After distillation, the citronella stalks are used as fuel in steam-generators, and can also be made into paper.

The cultivation of citronella is much to be recommended on account of the growing demand for geraniol, and the many ways in which citronella oil is employed. The best variety to grow is "Maha-pengiri," as the oil it yields is of superior quality. This plant requires a very hot, damp climate, and a rich soil. The cultivator must have plenty of labour at his disposal if a paying crop is to be obtained.

The French Colonies, thanks to the protective duties (which amount to an actual bonus of 1 fr. per kg.), could cultivate citronella to great advantage for the purpose of supplying the Paris market with essential oil.—INTERNATIONAL REVIEW OF THE SCIENCE AND PRACTICE OF AGRICULTURE, YEAR XI. No. 9.

* KEW BULLETIN, No. 8, 1906 pp. 302-364, The Oil Grasses of India and Ceylon. (ED.)

LIVE STOCK.

DISEASES OF SHEEP.

BERNARD A. GALLAGHER,

Pathological Division.

The following extracts have been taken from the FARMERS' BULLETIN 1155 of the United States Department of Agriculture :—

NON-CONTAGIOUS FOOT ROT.

Non-contagious foot rot is distinguishable, as described below, from the contagious form known as lip-and-leg ulceration.

Cause.—Purulent inflammation of the cleft in the foot may occur in sheep pastured in low, swampy lands, or from accummulation of clay mixed with twigs, stubble, sharp pebbles, etc., in the cleft.

Woods and cuts from stiff, pointed cut-over bushes, weeds, stubbles, etc., may become filled with sand and fine gravel and may result in lameness and pus formation.

The opening of the biflex gland, situated between the toes of sheep, may become plugged by mud or sand. This not only stops the flow of the oily secretion for lubricating the tissues in the cleft of the foot but causes inflammation and the formation of pus in the biflex canal.

Sores or abscesses varying in size from that of a millet seed to that of a silver dollar may appear just above the coronet or in the region of the ankle as a result of sheep having to wade daily through muddy or filthy yards or pens. The abscesses are caused by pus-producing organisms different from the organism of lip-and-leg disease.

Symptoms.—In all forms of non-contagious foot disease lameness is a prominent symptom. An examination of the affected feet, the fact that few animals suffer from the ailment in most cases, and a consideration of the probable causes will help one to distinguish the disease from the contagious foot rot known as lip-and-leg ulceration.

Treatment.—Foreign material, such as caked clay, sand, pebbles, etc., should be removed, wounds or cracks washed, abscesses opened with a clean sharp knife, and antiseptics, such as 5 per cent. carbolic acid or 2 per cent. compound solution of cresol, applied to the affected parts. Poultices may be applied to open abscesses and held in place for several days by a bandage. Portions of diseased or loosened hoofs should be cut away. Removal of the flock from muddy or filthy surroundings to dry, clean places checks the spread of the abscesses.

RABIES (HYDROPHOBIA).

Rabies is an acute, infectious disease affecting the brain, ending in paralysis and death.

Cause.—It is caused by a living virus which is transmitted to animals and man by the saliva of rabid animals through biting. Dogs are most frequently responsible for the spread of rabies, but any affected animal that bites another may transmit the disease.

Symptoms.—Symptoms begin between two and four weeks or somewhat longer after the animal is bitten. Death takes place in from two to eight

days later. There is loss of appetite and a stopping of rumination, great unrest, stamping of feet, and butting or charging others of the flock. The affected sheep will attack a dog or other intruder. The head may be carried high and a little to one side. Bleating is higher in tone and more plaintive. Increased sexual excitement is marked, especially in the rams, the animals continually riding one another indiscriminately. Sheep will nibble at wood and swallow indigestible material of any kind. Occasionally a form of dumb rabies is found, in which violent symptoms are not pronounced. Lambs have convulsive fits and die in a day or two. Paralysis of the limbs precedes death.

Post-mortem appearance.—No characteristic changes are observed in the internal organs, except through microscopic examination of the brain. The finding of small, round, foreign bodies, known as Negri bodies, in the brain cells, establishes a positive diagnosis of rabies.

Treatment.—Affected sheep cannot be cured. Those known to have been bitten by rabid animals may be protected against the disease by the Pasteur vaccine treatment if promptly given. This is expensive, but may be warranted in the case of valuable sheep.

FOOT-AND-MOUTH DISEASE (APHTHOUS FEVER).

Foot-and-mouth disease is a highly infectious, acute, febrile disease of cloven-footed animals. Horses, dogs, cats, poultry and even man may become infected. It is characterized by the formation of vesicles or blisters on the membrane of the mouth and on the skin between the toes and above the hoofs.

Cause.—The cause of the disease is too small to be seen with a microscope and is known as a filterable virus. Transmission occurs by direct contact with infected animals or by any agency, such as man, other animals, feed, animal products, etc., contaminated with discharges from affected animals.

Symptoms.—In sheep the lesions are more pronounced in the feet, the blisters being less well marked in the mouth than is the case in cattle. All four feet generally are the seat of small blisters, which form on the skin between the toes, on the heel, or around the top of the hoof. The animal is restless and kicks with hind feet. Pain becomes intense, severe lameness is shown, and the animal rests on the knees or breastbone in feeding or lies down most of the time. The blisters rupture, discharging a clear or yellowish fluid, which later may become cloudy or purulent. Frequently the hoof separates from the wall.

In the mouth small blisters form on the incisor pad, lips, tongue, cheeks, or hard palate. These rupture, discharging a clear fluid and leave small, reddened surfaces which heal rapidly. A considerable part of the membrane of the mouth may be cast off. The animal often makes a smacking sound or grinds the teeth.

Blisters may appear on the udder or teats. There is a general constitutional disturbance, diminished appetite, and loss of condition. The temperature rises at first and then drops to normal.

The disease runs its course in from two to three weeks, but is prolonged by severe foot lesions or by complications. The mortality is higher among lambs than among grown sheep.

Diagnosis.—Foot-and-mouth disease is readily recognized by the rapid spread of the disease in a flock, or to cattle and hogs, by the characteristic blisters on the feet or in the mouth and by the severe lameness in more than one foot. In foot rot of sheep, lameness is present in the affected foot; but in that case the lesions are in the form of ulcers, which usually develop at the heel and may extend deeply into the tissues, causing erosions which

discharge a purulent matter. A pungent, disagreeable odour also is quite characteristic of foot rot.

Treatment.—Antiseptic washes as Permanganate of Potash or alum lotion for the mouth —and Jeyes' fluid, Izal or Cresol and water for the feet— with an application of Stockholm tar and oil to the feet.

ANÆMIA (HYDREMIA, CHLOROSIS).

Anæmia is a condition in which the blood is deficient in either quality or quantity.

Cause.—It is most frequently due to insufficient feed or to feed deficient in proteins and mineral substances, such as iron. It occurs often in animals grazing on marshy pastures. Ewes suckling lambs become anæmic when the quantity or quality of feed is inadequate for their needs. Anæmia is also associated with chronic wasting diseases and with heavy infestation with parasites.

Symptoms.—The visible membranes of the eye, nose, and mouth are pale. There is dullness, weakness, and emaciation. A dropsical swelling forms under the lower jaw and may extend down the neck to the chest. The belly becomes dropsical. The wool is lustreless, harsh, or brittle, and falls off in patches. Diarrhœa is present in the late stages. The animal may die from loss of strength after several weeks, or the disease may continue for months.

Treatment.—Change of feed or pasture is essential. A sufficient quantity of nutritious feed should be given ; also administer iron sulphate (copperas) in from 8 to 15 grain doses daily. Arsenic in the form of Fowler's solution in from one-quarter to 1 teaspoonful daily and vegetable tonics, such as gentian or ginger, in from 1 to 2 teaspoonful doses are of value in aiding rapid recovery.

SORE EYES (CONJUNCTIVITIS, OPHTHALMIA, THE BLINDS).

Cause.—Disorders of the eye may arise from a number of causes. Inflammation may follow injuries, or inclusions of dust, seeds, pollen, etc., or may accompany other diseases, such as catarrh. At times inflammation of the eye becomes prevalent in a particular district or region.

Symptoms.—The eye is kept closed, especially when exposed to light. Tears flow freely. At first the discharge is watery, but later it may become purulent. The eye membranes are swollen and red. The eyeball may become clouded or milk white, and in bad cases it may ulcerate and rupture. Cataract and blindness frequently follow successive attacks of ophthalmia.

Treatment.—Any foreign matter in the eye should be removed. The eye should be washed with 3 per cent. boric-acid solution, or, better still, after washing the eyes with lukewarm water place several drops of 15 per cent. solution of argyrol on the eyeball. Treatment should be given twice a day, the animal being kept in a dark place if possible.

DISEASES OF THE DIGESTIVE SYSTEM.

Defective Teeth.

Animals which show poor condition, indigestion, or dropping the cud may be found upon examination to have supernumerary, defective, or broken teeth, diseased gums, or, in the case of old ewes, teeth may have fallen out. Defective or supernumerary teeth should be removed, or the affected animals prepared for slaughter.

DROPPING THE CUD.

Cause.—When an animal drops the cud, disease of the teeth or sore mouth may be looked for. In other cases it is due to acidity of the stomach or inferior feed.

Symptoms.—The contents of the stomach are returned to the mouth for mastication, but owing to acidity, bad taste, or to pain in chewing, the feed is dropped from the mouth. Quantities of half-chewed feed may be found on the ground.

Treatment.—The mouth or teeth should be attended to if found diseased. Baking soda in from 1 to 2 teaspoonful doses will counteract excessive acidity of the stomach. A purgative, such as Epsom salt in 4-ounce doses, may be given. A good quality of feed should be provided.

BLOATING (HOVEN, TYMPANITIS.)

Rapid formation of a large quantity of gas in the paunch causes a bloating or distension of the abdomen.

Causes.—Heavy feeding on various green feeds, such as alfalfa, clover, green oats, or pea vines, especially when wet or frosted, or on grains, frozen fruits or cabbages, turnips, etc., may bring on bloating. These feeds readily ferment when the paunch becomes inactive or paralyzed from overdistension and a large quantity of gas accumulates.

Symptoms.—Evidence of bloat is readily apparent. It appears first in the left flank as a tense swelling, which sounds drumlike on tapping with the hand. Breathing is difficult from pressure on the lungs, the animal is distressed, staggers, and drops to the ground. Death results from suffocation.

Treatment.—In acute cases the flank should be punctured in its most prominent part with a clean trocar and cannula and the trocar withdrawn to allow the gas to escape through the cannula. A stomach tube or small rubber tube passed down the gullet serves the same purpose. Large doses of antiferments and stimulants, such as aromatic spirits of ammonia, one-half ounce in 5 ounces of water, and turpentine, one-half ounce in 6 ounces of linseed or castor oil, should be given. Driving the animals through cold water or pouring cold water over the body is beneficial. Keeping the mouth open by gagging with a smooth stick tied behind the ears and massaging the paunch with the fist against the left flank will aid in causing a belching of gas.

DISEASES OF THE REPRODUCTIVE SYSTEM.

Abortion.

Cause.—Abortion in ewes may be due to a variety of causes. It may result when the animal is affected with a febrile disease; from feed containing molds, such as ergot; from being frightened or run by dogs; or from rough handling or injury. It aparently occurs also in some flocks as a specific infection due to abortion-producing micro-organisms.

Symptoms.—The animal about to abort is restless, bleats constantly, and has an offensive, glairy, discharge from the vagina. The lamb is usually expelled dead or dies in a short time. A portion of afterbirth may hang from the genital opening. In infectious abortion the ewe has a severe diarrhœa, a putrid, dark discharge from the vagina, and a necrotic afterbirth hanging from the vulva.

Treatment.—When several cases occur about the same time and no evidence of disease or injury is apparent the feed should be examined or changed. The genital passages may be washed out with compound solution of cresol in one-fourth of 1 per cent solution, or carbolic acid in 1 per cent. solution daily until the discharge ceases. Retained afterbirth should be removed if it does not come away in a day or two. The hand, instrument, and genital parts should be well disinfected before removal is attempted. Where abortions in the flock occur frequently and symptoms suggest infectious abortion, all aborting animals should be removed and the fetuses and

afterbirths destroyed. Liming the soiled areas or disinfection of pens is of great importance in preventing the spread of infection.

DEATH OF FETUS IN WOMB.

Death of the fetus in the womb may be manifested by metritis (inflammation of the womb) accompanied with a purulent discharge, or no external symptoms may be shown, and the fetus dries up or becomes mummified. In the former case the treatment as given for metritis is indicated. In the latter case the udder is milked out to guard against mammitis and the animal is fattened for slaughter.

EVERSION OF UTERUS AND VAGINA.

Causes.—Protrusion of the genital organs through the vulva may result from violent spasms of the uterus, severe straining, or from forcible extraction of the lamb.

Treatment.—The parts should be thoroughly cleaned, washed with a 2 per cent. carbolic-acid solution, and, after the fetal membranes are removed, gently forced back through the vagina. Sutures through the skin on each side of the vagina and passing over the opening will prevent a recurrence. If badly inflamed or gangrenous, the parts may be removed by proper surgical methods.

DYSTOCIA (DIFFICULT LAMBING).

The condition known as dystocia should be handled by a veterinarian or one thoroughly acquainted with the anatomy of the genital organs and the various positions which fetuses assume in presentation for birth. It is seen most frequently in ewes when they lamb for the first time. Parts of each of twin lambs entering the pelvic cavity at the same time are often responsible. When the head or legs are not presented in a normal manner or when the fetus is malformed dystocia is evident.

Treatment.—The ewe should be held and her genital passage and the hand of the operator lubricated with linseed oil. The fetus is pushed back into the uterus and rotated into position for normal presentation. A cord is passed over the feet, either fore or hind, according to the position of the fetus, and moderate traction applied as an aid to the efforts of the ewe. In assisting the ewe to pass the lamb care should be taken to see that the hands and instruments are disinfected and that no injury is done to the genital passage.

MAMMITIS (BLUE BAG, GARGET, CAKED UDDER).

Mammitis is an inflammatory disease of the udder and is frequent in ewes suckling young. It may occur in a mild or in a gangrenous form.

Cause.—It is generally due to the action of micro-organisms which multiply in the milk and tissues of the udder and set up inflammatory changes. Secondary influences, such as injuries, the loss of the young with consequent accumulation of milk in the udder, or systemic derangements favour the development of disease germs.

Symptoms.—One-half of the udder or the whole udder may be affected. The part is hot, swollen, and doughty, or hard. There is restlessness and pain when suckled. The milk secretion becomes thick, yellowish, and at times bloodstained. Gangrene of the udder, with bluish discoloration, may ensue.

Treatment.—The animal should be removed from the flock. The udder should be milked frequently and hot applications made ; also the part should be rubbed well or massaged. Turpentine liniment or tincture of iodine may be applied. Badly abscessed udders may be lanced, or the udder may be removed by a veterinarian. Animals which recover are usually fattened for slaughter.

POULTRY.

THE BREEDING OF GEESE.

MR. STANLEY STREET-PORTER has contributed an article on "The Breeding of Geese" as a profitable addition to the general or poultry farm to the JOURNAL OF THE MINISTRY OF AGRICULTURE for November, 1921, from which the following notes, which will be found useful to the local poultry keepers, have been taken :—

It has been recognised by the progressive farmers that poultry keeping on modern lines forms one of the most profitable adjuncts to general farming but breeding of geese is a branch of the industry that has heen neglected, although it is one of the most profitable to those possessing grazing lands.

The objection to breeding geese by farmers seems to be that they spoil the grazing for other stock, and it is commonly stated that cattle, etc., will not graze after geese, but this has now been disproved.

Geese do not need a rich pasture, but will grow and thrive in poor common land, Given suitable grazing there is probably no other branch of poultry keeping more profitable than the rearing of geese.

BREEDS.

The best known breeds are the Embden and the Toulouse, while the Chinese is also well known. For commercial purposes the "Roman" is supposed to be the best. The "Roman" geese are of moderate size and far more prolific as layers than most other breeds of geese—with the exception possibly of the "Chinese"—whilst the Toulouse is undoubtedly the best heavy-weight goose obtainable. The Toulouse are very massive and majestic in appearance and do not make the rapid growth of the Roman, but though they are slower in attaining maturity, they make fine heavy-weight geese by the end of the year. Toulouse geese usually commence laying in February, and after laying their first "clutch" of eggs, go "broody," afterwards laying a second, and as a rule smaller batch of eggs than the first. In colour the Toulouse are a dark grey with white under.

Roman geese are much smaller than either Toulouse or Embden. They have a very smart, alert carriage and are splendid foragers. In colour they are generally white, though some have grey markings on head and neck. They weigh from 12 to 14 lb. when mature, are finer in bone than the Toulouse, and carry more flesh in proportion to offal than the heavier breeds. They are probably the most prolific geese in existence. They breed quite satisfactorily without swimming water, and unfertile eggs are the exception.

Roman geese generally come into lay toward the end of January or early in February. Although they are rather addicted to broodiness, and will generally go broody four or five times during the season, if shut up at once they are easily broken of this, and can get to lay again in 7 or 8 days. If required to hatch their own eggs they make very reliable sitters and splendid

mothers. If it is wished to break them of broodiness they should be taken the first night they remain on the nest, put in a raised coop with slatted bottom and fed liberally, when they will soon recommence laying.

Embden geese are white and better layers than Toulouse and are frequently crossed with the Toulouse for producing market geese with good results.

BREEDING AND FEEDING.

In making pens for the breeding season one gander may be mated with three geese. Second or third season geese are most suitably mated to a year old gander, though good results may be obtained from first-season early-hatched geese of the Roman breed if mated to a second-season gander. It is preferable if the breeding stock can be given free range and swimming water.

Through the breeding season, particularly when geese are kept in comparative confinement, the birds should be fed liberally to obtain a maximum production and the best hatching results. During this period one good feed of grain and one of soft mash are given each day.

Geese require a greater proportion of animal food in their mash than fowls. Bran, middlings, maize meal, Sussex ground oats and fish meal in equal parts make a good, serviceable mash for the breeding season, while a grain feed consisting of equal parts of sound oats and kibbled maize fed in troughs in their drinking water is recommended. Grit and oyster shell should always be available for them in their drinking water.

For purpose of fattening geese should be shut up in an open-fronted shed and given all the food they will consume. This should be mainly a mash composed of maize meal, Sussex ground oats, barley meal, and if available some boiled potatos may be mashed up with the meal ; about 10 per cent. of fish meal or meat meal may be added with advantage. White oats of good quality, which should be steeped in cold water for some hours before feeding, also form an excellent food to produce fine quality flesh. Food may be given two or three times a day when fattening, but any food left over should be removed from the troughs after they have finished feeding : if left over until the next meal there is a danger of them going off their feed. Grit and fresh clean water should always be available, but the geese should not be allowed swimming water whilst fattening.

HATCHING AND REARING.

Hatching the eggs in incubators has not given satisfactory results, and, therefore, should not be resorted to if broody hens are available. If goose eggs are hatched artificially the temperature of the incubator should be 102°F. It is advisable to sprinkle the eggs once a day with water (with the chill off) and as soon as they begin to "chip" a piece of flannel or old blanket should be well soaked in warm water and laid over them for about 10 minutes.

Goslings can be fed practically the same as chickens or ducklings, with a little bran, middlings, Sussex ground oats and maize meal mixed with crumby. If given a chance to range they will soon provide for themselves. After the first fortnight during mild, open weather, they need not be fed at all if given free range, unless required for early killing.

APICULTURE.

BEE NOTES.

All bee-keepers will hear with regret of the death of MR. F. W. L. SLADEN, who was drowned in September last in Canada. He is referred to in an obituary notice in THE BEE WORLD, as a scientist, a distinguished bee-keeper of world-wide fame and a gentleman. Born in Kent in 1876 at the age of 16 he produced a book written, printed, illustrated and bound by himself.

In 1910 he identified the scent organ suspected by NASSANOFF. He also discovered the fact that bees so collected pollen in their baskets that the last load lies on the top. For the purposes of his experiments he made use of Duck Island, Ontario, and conclusively proved the value of Island stations to ensure the mating of selected queens with selected drones. It was in conducting these experiments that he met with his death.

The question of standardization is one that must always be before us. At present we are giving a trial to a frame which the Ceylon Bee-Keepers' Association has recommended as a temporary standard for *Apis indica* bees. Even in England the question of standardization has not been definitely settled. In 1882 a Committee of bee-keepers recommended for *Apis mellifica*, a frame 14 × 8½ inches (outside measurement) which was adopted as the British Bee-keepers' Standard. But with the advance of bee-keeping, many improvements have since taken place, and the W. B. C. hive, originated by MR. W. B. CARR has come into favour. In the U. S. A. the original Langstroth hive held 10 frames each 17¾ × 9 inches. The number of frames was subsequently reduced to 8. The improved Langstroth has a flat roof board allowing ¼ in. space between roof and top bars. The essential point, however, viz., the size of the frame, remains unchanged.

The Egyptian bee is scientifically known as *Apis mellifica-fasciata* Latr. The oldest record of Egyptian beekeeping is said to be about 4000 B.C., when the bee was used as a hyroglyphic for "King" on certain monuments. The native hive is a "mud-cylinder," of which Nile mud and cowdung are the chief ingredients. Swarming takes place between February and May. A colony may contain virgin queens while a fertile queen is in the hive. Moreover there are "half queens" that lay drone eggs. When laying workers occur, a great number (laying a few eggs each) take part in the egg-laying. It is further recorded that these bees favour the rearing of drones. Newly built combs have a darkish appearance. Even during a honey-flow there is no great inclination to build.

Says MR. J. J. KETTLE, F.R.H.S.:—"There is obviously a close connection between beekeeping and fruit growing; and, if intelligent educational propaganda in favour of bee-keeping be conducted among-fruit growers, it is sure to be productive and render a double service to the community. More fruit will set if cross fertilized than when the flowers are pollinated with their own pollen: the fresh pollen brought by bees helping to produce the greatest possible amount of fruit. This fact has been proved over and over again by experiments. This is no fairy story but a fact. There is little doubt that the time will soon arrive, when the fruit-growers will as a body appreciate the close connection between fruit-growing and bee-keeping, and do all they can to make of every fruit-grower a bee-keeper."

In reply to an enquiry made by the Secretary, Ceylon Bee-Keepers' Association, as to what is the accepted view about honey from poisonous plants, and whether the bee, in gathering nectar, eliminates the poisonous principle in certain flowers, the Editor of the BEE WORLD writes : "Where nectar is secreted for the attracting of insects—even by the flowers of poisonous plants—it cannot be expected naturally to be injurious. In fact the poisonous character of a flowering plant has nothing much to do with its nectar secretion, so far as our knowledge goes. Tobacco honey, for instance, has never been known to be poisonous, and, despite reports to the contrary, we have never seen bees in a narcotic condition on poppy flowers."

MR. A. P. GOONATILLEKE, writes : "There is a common belief among village folk that the honey-flow corresponds with the blossoming of the paddy crop in any particular locality, from which, I take it, we have to conclude that they believe paddy to be a prolific source of honey. My observations have not verified this theory : and I shall, therefore, be glad to have the experience of others who have had better opportunities for observing the behaviour of bees in the field.

"Another suggestion I would throw out is that local bee-keepers should endeavour to make as complete a list as possible of the honey-yielding plants found in the Colony."

C. D.

HOW BEES RECOGNISE A MASTER.

W. A. GOODACRE. ***Senior Apiary Inspector.***

When watching the apiarist manipulate his colonies, people not acquainted with the habits of bees almost invariably remark that the bees must know the bee-keeper, their idea being that otherwise the operator would be stung. Such an explanation is inaccurate, however, for the immunity of the bee-keeper is due rather to his understanding of the bees and his accurate anticipation of their behaviour in given circumstances than to the bees' recognition of their individual owner. Bees do, on the other hand, recognise the hand of the master in the manipulations of any bee-keeper whose procedure is competent and assured. They even seem to realise that it is useless, as well as inadvisable, to put up a fight against operations so deliberate and fearless.

In ordinary work the apiarist need use very little smoke, but what is delivered must be given at the right time, for the business of the apiarist is to detect the first signs of excitement and thereby prevent it from becoming general. The amateur bee-keeper has two cares—to preserve the serenity of the bees and to keep cool himself. Bees readily detect nervousness in man or beast ; cows can often remain among the bee-hives all day and will not be disturbed, while a horse will usually be cleared out within half an hour. Learn to work calmly and smoothly, carrying out manipulations deliberately and carefully, and using smoke only when actually required, so that the bees are not demoralised by it, and the idea of danger from stings will soon cease to obtrude upon the day's work.—AGRIC. GAZ. OF N. S. W., Vol. XXXII, Pt. 10.

GENERAL.

SOME RECENT WORK ON SEEDS.

W. BURNS, D. Sc.

The problems presented by the life and death of a seed are as yet by no means solved. A brief survey of some recent scientific work on these problems may be of interest to readers of this magazine both as practical farmers and as scientists.

The seed, as all know, is a living plant (embryo) associated with a store of food material either in its seed leaves or outside it in the endosperm, the whole enclosed in one or more seed coats of a texture which varies in different plants. That this plant is alive for a time at least is shown by the fact that it can be made to grow if we supply the appropriate conditions of temperature and moisture. It is unthinkable that any living organism should die and then come to life again, hence we must assume that, however old a seed is, if it can be made to germinate the embryo must have been alive all the time. There have been various stories current regarding seed of excessive age which nevertheless germinated. The most famous of these is the story of the "mummy wheat" taken from the sarchopagi of some of the Egyptian monuments, which seed was said to germinate. The facts of this story are as follows :—

A certain explorer named UNGER discovered a grain of wheat in a brick from the pyramid of DASHUR the date of which is known to be about 3300 B. C. Later SIR GARDNER WILKINSON stated that in the sepulchres of THEBES, of somewhere about the same date grains of wheat and other seeds were found dry and preserved, and he apparently said that these might possibly germinate. UNGER actually tried the experiment, but got no germination. Another worker, STEINBERG, said that he did get success, but his experiment is under grave suspicion, as the actual source of the seeds with which he experimented is doubtful. Such is human nature, however, that once the rumour got abroad that wheat seeds had been discovered in Egyptian tombs and that perhaps they might germinate, then immediately the story began to grow and to receive additions in the telling (as stories always do) until even to this day quite a number of people believe that wheat found in Egyptian tombs did germinate.

Actual scientific data above suspicion are, however, forthcoming regarding the longevity of seeds. In the GARDENERS' CHRONICLE of July 7, 1909, will be found an interesting article on the life and death of seeds. Therein is recorded some observations by EWART in Melbourne, Australia, on the germination of seeds taken from dated museum specimens which had been kept for over 25 years. About ten per cent. of the species tested gave positive results. Of these a specimen of seeds of *Hevea linearis*, 105 years old, germinated and also a specimen of *Cassia bicapsularis* 87 years old. In general seeds of the Leguminosæ in this experiment were most long-lived.

It is likely that this was due to the hard coat surrounding such seeds. Of course many of the Leguminosæ that are used as crop plants have not hard seeds, but on the other hand many of the wild species do. One has only to think of the babul and also of that plant known as *Gazga* with the seeds of which the little girls of the Maharashtra play the game called (in some places) Panchki. It is an interesting fact that this game and about four others are common to India and Britain. It would be a most interesting research to find out their origin and how they came to be games of the children of both countries.

Perfect drying is one of the best means of increasing the life of seeds when stored. Just as iron when damp rusts, that is, oxidises, so seeds containing moisture slowly oxidise and thus lose their power to germinate. Really dry seeds can also stand extremes of temperature much better. BECQUEREL, in Paris, showed that ordinary dry seeds were not affected by a cold of minus 250°C. and that a heat of 100°C. does not kill such seeds either.

Perfect drying will, of course, not preserve any seed indefinitely. There is an actual limit to the length of time a seed will live, and this limit is different for different species. Actual experiment has shown us that the mango seed, for example, does not usually live for more than a month. This is, of course, one of the most short-lived of seeds. Most of our cereals suffer considerable falling off in germination percentage after two years. This month I received a sample of two-year-old rice seeds that entirely failed to germinate in ten days. In Canada experiments showed that wheat remained constant for six years, and fell off till the 11th.

But seeds may be alive and still fail to germinate for some reason. One of the commonest reasons is the thickness and impenetrability of the seed coat. The seed coat of babul is amazingly thick and resistant, and the germination percentage in ordinary conditions is correspondingly low, being only from ten to twenty per cent. Steeping in water of 80 degrees Centigrade increased the germination percentage to 78. It was found that steeping the seed in strong sulphuric acid for six hours and then sowing, raised the germination percentage to 86. This shows how resistant the coat is. Similar treatment for hard seeds, namely the use of sulphuric acid, was recommended by FINLOW and BERGTHEIL in 1913.*

Hard coatedness is of course, merely a physical obstacle presenting no very great difficulties. More difficult to tackle are the physiological obstacles offered by some seeds.

There appears to be no doubt that the germination of many seeds will not take place until certain ripening processes have occurred within the seed. The exact nature of these processes is obscure, but there seems to be no doubt that the development of certain ferments, such as exidases and catalases, is necessary. The hastening of such ripening can be done in various ways. It is found, for example, that the seeds of wheat, barley, rye and oats sown immediately after threshing give a percentage of germination much lower than that obtained if the same seed is dried or is kept without special drying for two or three weeks.†

---

* FINLOW AND BERGTHEIL. A Method for Producing Immediate Germination of Hard Coated Seeds. JOURNAL ASIATIC SOCIETY OF BENGAL, New Series, Vol. III. p 625.

† STAPLETON AND ADAMS. The Effect of Drying on Germination. JOURNAL BOARD OF AGRICULTURE, 1919, July XXVI, 4, pp. 364-381

In the case of Juniper seeds, storage at 5 degrees Centigrade brought about the necessary ripening*. DE VRIES found that soaking under pressure improved the percentage of germination of *Oenothera* seeds.† In the case of orchid seeds it appears that in some cases at least the presence of a fungus symbiont is required before the seed will germinate§. We have not yet in our laboratories succeeded in getting the seed of the parasite *Striga* (Marathi: *Tahuli or Tavali*) to germinate, although it is said that contact with the host root will induce germination.

It has been claimed that electrification of the seed by passing an electric current through a salt solution in which the seeds are contained has increased germination, but the evidence for this is not conclusive §.

It is stated that Johnson Grass (*Holcus halepensis*) germinates best after being exposed to alternating temperatures while the closely allied Sudan grass (*Holcus halepensis sudanensis*) requires a constant temperature‖

In conclusion, how are we to think of the condition of the embryo during these long periods of dormancy? We must consider it alive but what sort of life is this? How can we prove it alive? One sign of life is respiration, and if one could detect a constant output of carbonic acid gas, even in small quantities, then one would consider life present. Delicate experiments have been made to settle this point, but different observes have got conflicting results. The life must be some sort of static equilibrium as opposed to the dynamic equilibrium of the actively growing plant, but we are still in the dark as to its exact nature. That we shall not always be so ignorant we may be sure, for no question put by nature is impossible of solution by the brain of man.—(POONA AGRI. COL. MAG.).—PLANTERS' CHRONICLE, Vol. XVI, No. 37.

GROUND COTTON SEED: AN EXCELLENT FEED FOR CATTLE.

CUTHBERT POTTS, B.A.,

Principal, Queensland Agricultural College.

There are several diverse elements in the present economic situation which have a close inter-relationship with regard to use of cotton seed as a feed, particularly for dairy cattle. Thus :—

(1) The war declared that we required to grow cotton within the Empire. Queensland is one of the countries where cotton of superior quality can be grown, and we are making strenuous efforts to induce our farmers to plant this crop.

---

* PACK. The Physiology of Germinating Juniperus Seeds. Science, April 9, 1920, p 374.

† GARDENERS' CHRONICLE, March 23, 1918, No. 4030, p. 124.

‡ GARDENERS' CHRONICLE, Aug. 28, 1920, p. 112.

§ GARDENERS' CHRONICLE, March 6, 1920, p. 113.

‖ T. G. M., DORMANCY IN SEEDS. AGRC. NEWS, XIX, 482, Oct. 16, 1920, p. 330.

(2) The price of butter has fallen, and is likely to go still lower.

(3) Wages have risen to a marked degree, and, though they may fall again, it cannot be expected that they will ever reach the low level of pre-war days.

Let us briefly examine how these three elements react on one another.

With regard to cotton, it is improbable that Queensland will grow this crop on big plantations. Rather, our development of cotton-production will be along the lines of planting comparatively small areas on each farm. This means that the cotton will have to be transported to some central station to be ginned. It has to be remembered, however, that after the removal of the lint there remains a large quantity of seed which has a high commercial value, both for the oil and feed nutrients it contains. If the oil is extracted and the residue is ground into a meal (cotton seed meal), it forms as rich a feed for stock as linseed meal. But if the oil is not extracted, the whole seed can be ground, as it forms an excellent cattle-fodder. The fact that cut cotton has to be removed from the farms for ginning largely prevents the farmers from appreciating the high feed value of cotton seed. But the feed value of the seed should be stressed, and, if once generally recognised, it will greatly enhance the commercial value of cotton-growing, Therefore, the seed from the gins should be returned to the growers for home consumption, or else it should be ground and sold on account of the grower. It is in this latter regard that dairy farmers can be of great assistance to the cotton-growing industry, and, by helping it, they will, incidentally help themselves.

As before mentioned, the price of butter has fallen, and is likely to go still lower. The dairy farmer can meet this adverse situation in one of two ways. Either he may increase the number of cows per milker, or he may keep the number of cows the same and only use those of high productive value. If he adopts the first course he will make his milkers slaves to their work, and this is entirely against the general trend of labour development, a development which justly aims at better wages and befter living conditions. If he adopts the second course, as he should, he has every chance of maintaining good returns, even against the lower prices for butter. Certainly, cows of high productive value cannot be readily bought at the moment, but they can be bred. Associated with such breeding, consistent herd-testing must be carried out. The present average production of butter per dairy cow per year is certainly below 150 lb. There is no reason why any dairy farmer should not improve his own herd so as to average 300 lb. to 400 lb. of butter per cow per year.

Quite obviously, if one man can manage twelve or fifteen or twenty cows, take whichever number you like, the wage he can earn is determined by the returns the cows give. If they average only 150 lb. of butter per year, the wage that can be earned is half of what could be got if the same number of cows averaged 300 lb. of butter per year.

But good cows cannot yield to their full capacity unless they get sufficient feed. Again, good cows pay to feed. To have a cow capable of giving 400 lb. of butter-fat per year, and to so feed her that she only gives 200 lb., is as bad as buying a 20 horse-power engine when your heaviest work only requires 5 horse-power,

In the foregoing an endeavour has been made to show that the dairyman can hope to meet falling butter prices only by using improved stock. Once he gets this improved stock he must prepare to feed them in the off-season, so as to obtain the greatest profit from them. For this feeding nothing could be a better concentrate than ground cotton-seed meal. This has been used at the Queensland Agricultural College for the past two years, with excellent results.

Some idea of the value of ground cotton-seed as a cattle feed may be formed by a study of the following descriptive details :—

In appearance, ground cotton seed is not attractive. Adhering to the seed there is a small amount of lint, and after grinding the meal it seems to contain a large amount of hairy fibre. The amount of this, however, is not great, nor has it any of the properties of hair. The cotton present is a vegetable fibre similar to the indigestible matter contained in all vegetable matter, and it has no bad effects on the animal. The flavour of cotton seed does not attract animals, and they may take a little time to get used to it. Once they get accustomed to it they eat it readily. Because cotton seed has a tendency to bind the animal, it should not be used in excessive quantity. Probably 5 lb. to 6 lb. per cow per day would be the greatest amount that should be used.

In order to obtain some idea of the comparative value of good cotton seed, the following grain rations have been run out :—

	No. 1.	No. 2.	Difference.
	lb	lb.	lb.
Bran	194	162	32
Crushed Wheat ...	33	28	5
Crushed Maize ..	329	63	266
Linseed Meal ...	244	153	91
Ground Cotton Seed ..	—	394	—

Each of these feeds is of equal value for milk production, and would be used up to 1 lb. for each 3 lb. of milk given.

Thus, 394 lb. of ground cotton seed has the same value as the sum of the quantities shown in the third column above. If we take bran at ¾*d.* per lb., crushed wheat at 1*d.* per lb., crushed maize at 1*d.* per lb., and linseed meal at 1½*d.* per lb., the value of the cotton seed works out at about 1*d.* per lb., or, roughly, £9 per ton of 2,000 lb.

Ground cotton seed can be used for cattle, horses, and sheep, but it cannot be safely fed to pigs.—QUEENSLAND AGRICULTURAL JOURNAL, Vol. XVI, Part 2.

DIRECTIONS FOR PLANTING UPLAND COTTON.

Cosmopolitan Character of Plant.—Under favourable climatic conditions, cotton will thrive on a great variety of soils.

A well-drained soil and a sheltered situation should be chosen.

Drought-resistant Habit.—The plant is a deep rooter, and naturally drought-resistant once it is firmly established, but responds to good cultivation and will return heavier crops where the surface soil is thoroughly prepared beforehand and moisture stored up in the subsoil and conserved by regular cultivation for the use of the growing crop.

Well-prepared Land Essential.—Land that is ploughed and cross-ploughed (not necessarily deep), say to a depth of 6 or 7 in., should be worked up to a good tilth on the surface prior to the seed being sown. In this way germination is assisted and a supply of plant-food made readily available.

A Good Crop for Scrub Land.—Cotton is a suitable crop for, and thrives well on, naturally burnt-off scrub land, the seed being sown in "hills" amongst the stumps and logs. Two or three seeds are sown to each "hill" spaced about 2 ft. apart.

Thinning should be carried out when the plants reach a height of from 6 to 8 in., the strongest plant being allowed to remain.

Weeds should be destroyed by hand cultivation and the surface soil surrounding the plants kept in a loose, friable condition.

Sowing Seed on Cultivated Land.—Five or six pounds are sufficient for an acre when care is exercised in planting.

Where a single-horse maize drill is used for planting the seed very light furrows may be run out 4 ft. apart with the plough, and the seed drilled in the furrows, or a marker may be used, marking three rows at a time. Prompt harrowing immediately after these operations is necessary.

Rapid and economical planting is assured by the use of a two-row maize planter.

Distance between Plants in the Row.—A good average space between young growing plants is from 8 to 10 in. It is necessary, however, to thin these out when they are several inches high, leaving one strong plant at intervals of from 20 to 24 in.

Wide planting of upland cotton induces the formation of "vegetative" (weedy) branches, to the detriment of the "flowering" (budbearing) branches, and a consequent reduction in its cropping capacity.

Treatment of Seed.—Owing to the short fluffy fibres adhering to the seed, it must be treated prior to attempting to pass it through a drill. Puddled clay or flour paste is commonly used for this purpose. Seed is dipped, in small quantities, into a vessel containing either of the above mixtures, the best consistency for which is readily ascertainable by a little practice. That treated with puddled clay should be rolled by hand on a sieve or other suitable surface, and the seeds made up to resemble small marbles, which must be allowed to dry out in the sun; when drying out, careful handling is necessary.

The flour-paste-treated seed is dipped into the prepared paste and drained and dried so that the seeds do not stick together.

Time to Plant.—Other things being favourable, the time for planting seed varies according to climatic conditions ruling in any particular district, and may be carried out as soon as danger from frost is over—up to October, and, in some localities, November.

Period of Maturity.—The crop takes from four to four and a-half months to mature. As the whole of the bolls do not ripen at once, it is necessary to go through the crop every few days and gather these which are thoroughly dry and have fully exposed their cotton.

Harvesting.—Picking should not commence until the dew has completely dried off the cotton.

The strict care should be exercised to keep the seed cotton free from leaves, sticks, dirt, or foreign matter of any description, and stained or discoloured cotton should not be mixed with the clean, sound, marketable sample.

Clean bags or bales must be used for the reception of the crop. These should be legibly branded before despatch to their destination.—QUEENSLAND AGRIC. JOUN. VOL. XVI, PART 5.

BANANA PLANT FIBRE.

The commercial possibilities of banana plant fibre has engaged the attention of planters and others interested from time to time, and some Tweed River growers have had under consideration the formation of a syndicate to thoroughly explore these possibilities.

A number of banana-fibre products have been submitted to our inspection, and as samples they appeared to be all that could be desired. A textile product woven from processed fibre had a fine silky appearance, and its value as a possible substitute for panama hat material was suggested. Another possibility is the production of vegetable silk from the residue of the treated material after the fibre has been extracted.

The question of the value of fibre from the stem of the banana is a recurring one, and should be approached with all due caution. In the West Indies many years ago, SIR D. MORRIS, D.Sc., D.C.L., F.L.S., Director of Public Gardens and Plantations, Jamaica, devoted close attention to it. One of his successors, WILLIAM FAWCETT, B.Sc., F.L.S., in his work, "The Banana: Its Cultivation, Distribution, and Commercial Uses" (1913), p. 151, says :—

"The stem (banana) yields less than 1½ per cent. of its weight, that is about 1½ lb. ordinary stem as cut. . . . To obtain 1 ton of fibre it would therefore be necessary to handle nearly 100 ton of fresh stems, which must be dealt with as soon as cut, on the spot. . . . It is considered that the value, as manure, of the chopped stem is perhaps two or three times the value of the fibre. No reasonable person would wish to export fibre to the detriment of his land. . . . The banana and plantain are grown primarily for the fruit, and not for fibre.

"In 1905, when the subject was under discussion, SIR D. MORRIS sent the following communication to the Jamaica Agricultural Society (JOUR. JAM. AG. SOC., X 2, 1,006) :—I enclose a summary of the facts obtained as the result of experiments during the last twenty years. They are as follows :— A banana stem just after fruiting, if cut, as usual with the country people, about 2 feet above ground, and denuded of its foliage, weighed 108 lb.; this being divided into three lengths of 2½ ft. each, and split longitudinally into several pieces, was prepared by beating and washing by hand, and yielded 25 oz. of clean marketable fibre which is at the rate of 1 44 per cent. of the gross weight. The fibre of the lower portion of the stem, as also the fibre in the petioles of the leaves, was not extracted.

"'A smaller banana, cut under similar circumstances. . . . weighed 41 lb. This was divided into two lengths of 2½ ft. each, and, after being split longitudinally into several pieces, was prepared by hand, and yielded 6¾ oz. of clean fibre, or at the rate of 1·02 per cent. on the gross weight.

"'At the Hope Plantation, similar experiments were conducted with banana stems, which yielded very much the same results. Two banana stems, cut after fruiting at 2 ft. from the ground, and denuded of their leaves, weighed 147 lb. These yielded 33 oz. of clean fibre, or at the rate of 1·44 per cent. on the gross weight.

"'From ordinary stems of banana, cut after fruiting at about 1½ to 2 ft. above ground, a settler might prepare about 1½ lb. of clean fibre ; but if the stems are large, and the whole of the length is used as well as the petioles of the leaves, the amount of the fibre might be increased to 2½ lb., if not 3 lb. per stem. . . . . .

"'It must be borne in mind that to obtain 1 ton of banana fibre it will be necessary to handle nearly 100 tons of fresh stems. These cannot be carried to a central place for treatment, as the cost of the fibre would be increased beyond its market value. The stems will be required to be dealt with on the spot. . . . . '"—QUEENSLAND AGRI. JOUR. Vol. XVI. Part 2.

THE CULTIVATION OF DIFFERENT VARIETIES OF COFFEE PLANT IN TONKIN.

M. BOREL.

Contrary to what is maintained by some authors, the author states that coffee-growing is a paying industry in Indo-China, except at an unusual time like the present, when the value of the *piastre* is extremely high. He, however, considers that *Coffea robusta* is not suited to Tonkin. In fact from its not being able to stand occasional cold winters, it is useless to grow it there, although it may do well in Cochin China and South Annam. The author has been trying for 12 years to cultivate it in Tonkin but has finally resolved to up-root the 6,000 plants he had at Da-Han, although they are in excellent condition, and only to keep a few individuals to serve as a control, like those in his plantation at Bavi.

Coffea liberia, like *Coffea robusta*, is not a variety for Tonkin. While the average yield of *C. arabica* at Da-Han, and Bavi, was 500 gm., per plant, that of *C. robusta* never exceeded 150 gm. At the last picking, 2 kg. were obtained from *C. excelsa* (Chari) ; 900 gm. from *C. arabica* and 150 gm. from *C. robusta*. All the varieties had, however, received the same care.

It must not be supposed from these figures that *Excelsa* is an ideal variety; its berries are most susceptible to the cold January fogs, for as they are not ripe before July, they are not fully developed so early in the winter. The 1919 crop was good, thanks to the mild winter, but other years, the yield was only 600 gm., to 1 kg., in the Da-Han plantation, where the plants received the same attention as the *Arabica* variety. It should be mentioned that there are only 500 *Excelsa* plants per hectare, as against 1,000 *Arabicas*. —INTERNATIONAL REVIEW OF SCIENCE AND PRACTICE OF AGRICULTURE, Year XI, No. 10.

PRUNING CITRUS TREES.

The following is extracted from FARMERS' BULLETIN 1,122 of the U.S.A. Department of Agriculture:—

When properly headed at planting time citrus trees require little pruning later. The general methods of pruning the trees when they are first set out were described in connection with the planting directions.

The pruning given during the first few years of the tree's life should be a continuation of that started when the trees were planted. All undesirable branches should be removed while they are still small and three or four limbs developed as a framework. Long, weak limbs that do not show a tendency to branch should be headed back, so that the tree will be kept strong, compact, and symmetrical. The top of the tree should not be allowed to become too dense, while on the other hand it should not be left so open that the trunk and inside branches are exposed to sun scald. Whenever it is necessary to prune off limbs whose removal will leave the inner branches exposed to the sun, the exposed branches should be protected from sun injury by a liberal coat of whitewash applied to reflect the heat. Well cared for bearing trees will need but little pruning. This pruning may be done at any time of the year when most convenient. Most growers prune in summer when other work is slack. The most important object is the removal of all dead, decayed, and injured wood. Such wood when left provides a breeding place for the fungus which causes melanose and stem-end rot, and the removal of this wood will tend to reduce the chances of these diseases developing.

It is best to maintain trees in good shape by pruning moderately every year, as heavy pruning is objectionable when trees have been long neglected. However, it is often advisable to prune them severely in order to put them into shape for good production. After a heavy pruning of this sort a vigorous growth of suckers, or water sprouts, will appear. These should be removed at once, except such as may be desired for developing into permanent branches. Sometimes a few water sprouts are left along the trunk and inner limbs and pinched back to form short inner fruiting branches. With most trees, however, the shade is too dense to favour much fruiting of these inner branches.

The principal tools used in pruning are the hand shears, knife, and saw. All tools should be kept as sharp as possible. It is very important to make the cuts clean and close to the trunk or branch left. Stubs should never be left, as they do not heal over well and eventually cause weak places in the tree. The large cut surfaces may be coated over with liquid grafting wax or white lead paint.

DEMONSTRATION OF FLAX-PULLING MACHINES.

An account of some public trials of flax-pulling machines conducted by the Irish Department of Agriculture and Technical Instruction is given in the JOURNAL OF THE MINISTRY OF AGRICULTURE for November, 1921, from which the following notes have been taken :—

The machines took part are :—

(1) The CRAWFORD-BENNETT Machine made by the York Street Flax Spinning Co., Belfast.

(2) The Fibre Corporation Machine made by MESSRS. MARSHALL, Sons & Co., Ltd., of Gainsborough.

The CRAWFORD-BENNETT Machine is self-propelled, and the Fibre Corporation Machine is built to attach to a motor tractor.

The full details of both the machines and how they have worked have been recorded. The quality of flax left unpulled by these machines under the ideal condition of the trial was scarcely significant, being for the most part, short stems which usually fail to survive the operations culminating in scutched fibre. It is doubtful whether either machine would be able to deal with any crop if "laid" at all.

In the performance of these two machines there appears to be a very big advance towards solving the flax pulling problem, and with the prospect of further improvements before next season, one may reasonably hope that the machine pulling of flax crops will be commercially possible at no distant date.

PHOSPHORUS IN BUTTER.

In the course of an exhaustive treatise on the above subject, by J. T. CUSICK (in Memoir 30 of the Cornell University Agricultural Experiment Station) the following conclusions are noted :—

1. In churning, about one-fourth of the total phosphorus of the cream is retained in the butter made therefrom, The remaining three-fourths is lost in the buttermilk, wash waters, and exudates during the salting process.

2. The methods of treatment of milk and cream before churning have an influence on the amount and the form of phosphorus retained in the butter,

3. In storage the soluble organic phosphorus compounds break down, giving inorganic phosphorus compounds.

4. The methods of treatment of milk and cream before churning determine how soon after storage organic phosphorus compounds will assume the inorganic form.

5. Salt in butter has a marked effect in bringing about protein decomposition during storage, even at a temperature of—10°C.

6. The new protein of milk which is soluble in alcohol exists also in butter.

7. Under certain conditions, bacteria are the controlling factors in bringing about chemical changes in the phosphorus compounds of butter.

8. The breaking-down of lecithin and the forming of trimethylamine is the cause of fishy flavor in butter.

9. When fishy flavor develops in butter there is always an appreciable loss of soluble organic phosphorus,

RED POLL CATTLE.

In view of the present policy of the Government of keeping Red Poll Bulls at the Stock Farm for breeding purposes, it may be interesting to give some particulars of the values of this breed both as a producer of both beef and milk in England and the United States.

MR. FRENK NELSON in the BREEDER'S GAZETTE for December 25th, 1919, states that the breed originated in the Norfolk and Suffolk districts of England and has never been crossed with any other breed. The great value of the breed is that it has been found possible in it to select for both beef and milk at the same time. In England Red Polls hold the carcass dressing percentage record (73·58 per cent.) over all other breeds, while in America fifty cows of one herd have a yearly average official butter-fat yield of 4·68 per cent.

To show how the dual nature of the breed can be developed, it is pointed out that "all the world's Red Poll butter-fat and milk records are held by one American herd," while "the 1917 Champion Red Poll Steer at the International show came indirectly from the same herd,

The LIVE STOCK JOURNAL of October 15th, 1919, states that "The Sutton herd of MR. CARLYLE SMITH which comprises typical dual-purposes Red Polls, includes a three year old heifer which has just yielded a ton of milk in six weeks. In another herd there is a cow, purchased at Gressenhill, which in five weeks and five days ending September 30th gave a ton of milk."

MR. NELSON concludes that "the success of the Red Poll in the feed-lot and the slaughter tests, coupled with the winning of the first, second and third in the recent Royal Dairy Show of England emphasises anew the superior claims of the breed.—BULLETIN DEPT. OF AGRIC., TRINIDAD AND TOBAGO, Vol. XIX, Part 2.

GRAFTAGE OF COFFEE.

P. J. WESTER,

Agricultural Adviser.

Coffee plantations throughout the world are nearly all planted to seedlings. Only in Java are grafted coffee trees set out on a plantation basis, and even there the areas planted are still comparatively small when the coffee industry as a whole is considered.

When seedling trees are set out a certain percentage may be expected to turn out to be "slackers," therefore, with a view to obtaining the maximum production of coffee, planters of the new rust-resistant coffees introduced from Java should topwork all poor bearers with scions from the most productive and desirable trees.

Cleft grafting and shield budding are the only practicable methods of graftage for coffee.

In topworking seedlings in the plantation cleft grafting should first be employed. If the work is carefully done about 85 per cent. of the grafts should grow into trees. The stumps of the unsuccessful grafts will soon send out a number of young growths. These can to best advantage be shield-budded, or they, too, may be cleft-grafted if it is desired. Shield budding of coffee seedlings two or more years old is impracticable because the bark is too brittle. For the same reason side-grafting with the scion inserted as in shield-budding, pushed downward, is not practicable.

Every coffee grower knows that a coffee tree has two distinct growths. The stems or upright growths, and the branches or lateral growths. Buds or scions taken from a stem or "sucker" or "water sprout" issuing from the stem of the parent plant will grow into normal trees, but scions taken from a branch of horizontal growth grow into branches only. They never produce stems, never grow upwards. For this reason stems only should be used as scions.

The scions should be well matured and from green to brown or blackish in colour. The leaves should be cut off the scions two weeks in advance of the budding while they are still attached to the parent plant, to allow the formation of well healed leaf scars, for petioled buds will fail. On the other hand, this treatment is not necessary for scions used for cleft grafting.

In cleft grafting, the old coffee plant should be cut off not more than 30 centimeters above the ground, and a cleft made in the stumps with the aid of a stout, sharp knife and a mallet or hammer. Then, the scion should be cut from 5 to 8 centimeters long, and the base of it cut into a long wedge and inserted into the cleft, after which the scion and stock should be firmly bound with waxed tape and all wounds carefully waxed. Subsequently all growths issuing from the stock should be rubbed off every ten days in order to force the sap of the stock into the scions. After the scion has taken and has made a good growth the dead, exposed wood of the stump should be kept carefully painted with white lead or coal tar until the wound is entirely healed, to keep decay from setting in and borers and termites from entering.

THE CULTIVATION OF TOBACCO PLANTS.

C. J. TREGENNA,

Tobacco Expert.

After transplanting, frequent working of the soil is the secret of the best results. To keep the field clean from weeds alone is not sufficient to ensure first-class tobacco. The first cultivation should take place with the hand hoe eight to ten days after the plants have been set out. Fairly deep cultivation is desirable in the first instance, but as the plant grows care should be taken not to hoe too deeply. Tobacco which is grown under irrigation should be cultivated after each watering, as after "topping" the plant cultivation should cease.—AGRIC. GAZ., N. S. W. Vol. XXXII, Part 12.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st DECEMBER, 1921.

Province, &c.	Disease.	No. of Cases up to date since Jan. 1st, 1921.	Fresh Cases	Recoveries.	Deaths.	Balance Ill.	No. Shot.
Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	84	—	84	—	—	—
	Anthrax	—	—	—	—	—	—
	Piroplasmosis	6	—	4	2	—	—
Colombo Municipality	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	107	16	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	2	—	—	—	—	—
Cattle Quarantine Station	Rinderpest	31	2	—	—	—	—
	Foot-and-mouth disease	54*	—	—	—	—	—
	Anthrax	397†	22	—	—	—	—
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	14	—	14	—	—	—
	Anthrax	—	—	—	—	—	—
	Piroplasmosis	19	—	12	7	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	35	—	35	—	—	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	Free					
	Foot-and-mouth disease						
	Anthrax						
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and mouth disease	245	—	236	9	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	36	—	11	23	—	2
	Foot-and-mouth disease	56	7	54	2	—	—
	Anthrax	—	—	—	—	—	—
North-Central	Rinderpest	Free					
	Foot-and-mouth disease						
	Anthrax						
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	526	96	479	9	38	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	20	—	2	18	—	—
Sabaragamuwa	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	364	315	268	1	94	1
	Anthrax	—	—	—	—	—	—

* 7 cases occurred amongst sheep and goats. † Occurred amongst sheep and goats.

G. W. STURGESS,
Government Veterinary Surgeon.

Colombo, 11th January, 1922.

METEOROLOGICAL.

DECEMBER, 1921.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of cloud 0=clear, 10=overcast	Mean Wind Direction during month	Daily Mean Velocity.	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from Average
	°	°	%			Miles.	Inches		Inches
Colombo Observatory	80·5	+ 1·6	75	6·2	N	166	3·96	10	- 0·73
Puttalam	77·4	- 0·2	80	5·8	NE	150	7·41	15	+ 1·24
Mannar	79·0	+ 0·2	74	7·1	NE	265	10·80	12	+ 2·98
Jaffna	77·6	0	80	6·4	NE	149	9·34	14	- 1·34
Trincomalee	78·5	- 0·2					30·55	18	+16·59
Batticaloa	78·2	+ 0·2					17·76	19	+ 1·08
Hambantota	78·9	+ 0·4	80	6·5	NE	320	3·50	12	- 1·98
Galle	78·8	+ 0·4	84	6·6	Variable	116	2·89	10	- 3·84
Ratnapura	79·8	+ 0·4	80	7·2	—	—	4·18	12	- 4·76
Anu'pura	76·4	- 0·6	82	6·9	—	—	12·10	15	+ 3·21
Kurunegala	78·2	+ 0·1	—	6·2	—	—	6·63	10	- 0·94
Kandy	74·8	+ 0·4	80	6·2	—	—	7·07	14	- 2·01
Badulla	70·7	- 0·1	86	8·4	—	—	10·75	20	- 1·71
Diyatalawa	64·8	- 0·3	86	7·7	—	—	5·81	20	- 2·44
Hakgala	58·0	0	93	8·9	—	—	8·99	21	- 4·66
N. Eliya	58·5	+ 0·7	83	7·8	—	—	6·04	16	- 2·59

During the greater part of the month the distribution of pressure was of the normal "north-east monsoon" type with wind from North or North East. Two periods stand out as noteworthy:—On the 8th the distribution became irregular in the east and there was heavy rain on the 8th/9th including Trincomalee 8·50 inches. The distribution however became normal again within a couple of days.

On the 26th a very definite depression appeared East of Batticaloa and proceeded to cross the northern half of the Island. The wettest day was the 27th/28th on which St. Martins (Rangalla) recorded 21·51 inches and Kobonella 13·80 inches, Trincomalee had 11·11 inches while most stations in the Eastern Province, and many of those in the North-Central Province, had about 9—10 inches.

Subsequently in the last three days of the month the local thunderstorms that often follow such depressions, gave the other parts of the island a little attention (e.g. Yataderiya). The effect on monthly totals can best be summarised if we draw a line from Puttalam south-eastward through Kurunegala and Kandy to near Welimada and then continue it eastward through Badulla to Arugam Bay. We can then say roughly that the area south-west of this line received less than 10 inches and was in nearly every case below its December average, while north east of it the rainfall was both over 10 inches in amount, and above its own December average at practically all stations on the mainland, though there was a slight fall off in and near the Jaffna Peninsular.

The highest monthly totals were, roughly speaking, in the areas that have already been mentioned in connection with the 27th/28th and include St. Martins 65·60 inches, Hendon Estate 50·69 inches, Periyakulam 35·78 inches, Kobonella 34·10 inches, and Keenakelle 31·70 inches.

Of the area whose rainfall was below average deficits in the Western and Central Provinces were nearly all less than 5 inches and frequently less than 2 inches. Deficits of over 5 inches were common in Sabaragamuwa and the Southern Provinces and there were a few in Uva in the Udahena district, but no deficits of over 10 inches were reported.

Temperature offsets were not large, Colombo alone being more than 1 degree from its December average.

The amount of clouded sky was decidedly above normal, while humidity was well below normal at the coast but slightly above it inland. Wind velocities were on the whole higher than usual but not so at Colombo.

J. BAMFORD.